AL. 2.1996-14
c. 2

ALTERNATIVE
AND
MINIMUM IMPACT TECHNOLOGIES
FOR
REMOTE TOURISM DEVELOPMENTS

CANADIANA

MAR 14 1995

FINAL REPORT

AUGUST, 1994

NOR'WESTER
ENERGY SYSTEMS LTD.

Digitized by the Internet Archive
in 2015

https://archive.org/details/alternativeminim00norw

ALTERNATIVE
AND
MINIMUM IMPACT TECHNOLOGIES
FOR
REMOTE TOURISM DEVELOPMENTS

FINAL REPORT

AUGUST, 1994

NOR'WESTER
ENERGY SYSTEMS LTD.

Alberta
ECONOMIC DEVELOPMENT
AND TOURISM

12th Floor, Commerce Place
10155 - 102 Street
Edmonton, Alberta T5J 4L6

TO WHOM IT MAY CONCERN:

Alberta Economic Development and Tourism is pleased to release this study titled: "Alternative and Minimum Impact Technologies For Remote Tourism Developments".

Much of Alberta's tourism both depends upon, and affects the quality of the natural environment. Developing tourism facilities in remote or unserviced locations presents a challenge, but is not insurmountable. Alberta Economic Development and Tourism, as well as the tourism industry and the public, are interested in environmentally sensitive developments. This study is intended to identify a range of feasible alternative and minimum impact technologies and management systems, which would be useful for consideration both by established facilities and new developments.

Alberta Economic Development and Tourism has for some time been compiling information on environmentally sensitive technologies and management systems. We would welcome receiving information from any suppliers or associations who wish to be added to our lists. In addition, we welcome enquiries from those wishing to make use of available materials on this topic.

If you have any comments relative to this report, please contact:

Alberta Economic Development and Tourism
12th Floor, Commerce Place
10155 - 102 Street
Edmonton, Alberta T5J 4L6

Telephone: 427-2501

The Government of Alberta disclaims any liability in negligence or otherwise for any loss or damage which may occur as a result of reliance upon the material contained in this study.

It should be noted that this study was conducted by an independent consultant commissioned by Alberta Economic Development and Tourism. As such, this study does not represent government policy nor does it imply any commitment to implementation at this time.

Yours sincerely,

Jim L. Engel
Assistant Deputy Minister
Small Business and Tourism Development

♻ Printed on Recycled Paper

ALTERNATIVE
AND
MINIMUM IMPACT TECHNOLOGIES
FOR
REMOTE TOURISM DEVELOPMENTS

prepared by:

Nor'wester Energy Systems Ltd.
100 - 3553 - 31 St., NW
Calgary, AB T2L 2K7

MPE Engineering Ltd.
260 - 2635 - 37 Ave., NE
Calgary, AB T1Y 5Z6

Willow Root Environmental Ltd.
P.O. Box 995
Banff, AB T0L 0C0

for:

Alberta Economic Development and Tourism
Edmonton, AB

August 1994

For additional copies of this publication and/or further information, contact:

Development Services Branch
Alberta Economic Development and Tourism
12th Floor
Commerce Place
10155 - 102 Street
Edmonton, Alberta
T5J 4L6
Telephone: (403) 427-2501

Nor'wester Energy Systems Ltd., MPE Engineering Ltd., and Willow Root Environmental Ltd.
"Alternative and Minimum Impact Technologies for Remote Tourism Developments"

ISBN 0-7732-1668-5

© 1994 Her Majesty the Queen in Right of the Province of Alberta.

No part of this publication may be copied, in any form or by any means, without written permission from Alberta Economic Development and Tourism.

Table of Contents

Table of Contents ..... **iii**
List of Tables ..... **iv**
1.0 Executive Summary **1**
2.0 Introduction **7**
  2.1 Purpose 7
  2.2 Methodology 7
  2.3 Notice 9
3.0 Energy Sources and Systems **11**
  3.1 Introduction 11
  3.2 Technology Overview 11
  3.3 Technology Summary 17
  3.4 Conclusions 17
4.0 Water and Sewage Management Technologies **19**
  4.1 Introduction 19
  4.2 Technology Overview 21
  4.3 Technology Summary 30
  4.4 Conclusions 33
5.0 Waste Management **35**
  5.1 Introduction 35
  5.2 Waste Management Strategies 37
  5.3 Technologies and Practices 43
  5.4 Conclusions 43
6.0 Life Cycle Costing **45**
  6.1 Why Life Cycle Costing? 45
  6.2 Method 46
  6.3 Cautions 50
  6.4 Conclusions 50
7.0 Conclusions **54**
  7.1 General 54
  7.2 Energy Sources and Systems 54
  7.3 Water and Sewage Management 55
  7.4 Waste Management 55
  7.5 Life Cycle Costing 55
8.0 References **56**
9.0 List of Appendices **57**

For additional copies of this publication and/or further information, contact:

Development Services Branch
Alberta Economic Development and Tourism
10th Floor
Commerce Place
10155-102 Street
Edmonton, Alberta
T5J 4L6
Telephone [illegible]

Note: [illegible]

ISBN 0-7732-1658-3

© 1994 Her Majesty the Queen in Right of the Province of Alberta.

No part of this publication may be copied, in any form or by any means, without written permission from Alberta Economic Development and Tourism.

List of Tables

Table 1 Summary of Major Factors Influencing Appropriateness of Water/Sewage Technologies 32
Table 2 Electrical Energy Worksheet 47
Table 3 Fuel Needs Worksheet 47
Table 4 Life Cycle Cost Example 49
Table 5 Single Present Worth Factors 51
Table 6 Uniform Present Worth Factors 52
Table 7 Loan Payment Table 53

1.0 Executive Summary

In Alberta, proposals for new tourism operations in remote and unserviced locations are under consideration. These may be proposed for sensitive environments. There is concern by the public, agencies and the industry, that developments should be appropriate to the environment in which they are proposed, and that they reflect sensitivity for the environment in which they are located. The public, in particular, is concerned about systems such as energy and water use, and waste and sewage disposal.

This work begins to demonstrate the range and type of approaches to planning, design, construction, equipping, and operation of such an environmentally responsible establishment, by reviewing the alternate technologies and practices available in three broad categories: energy, water and sewage, and waste management. A life cycle costing methodology is also presented as a means of evaluating the costs of the various alternatives on an equal basis.

The work was based on having relevant applications for two example facilities :

- a stand alone lodge which would accommodate 25 people, including staff
- a lodge with family unit cabins, to accommodate a total of 60 to 70 people, including staff

The majority of the technologies or practices reviewed are applicable to both examples, the difference only being a matter of scale. Costs and applicability are very site specific as the available resources and facility amenities are widely variable.

Matrices were developed which give brief details for each technology/practice about feasibility, costs, advantages and disadvantages, seasonality, impacts, benefits, disadvantages, reliability, etc. Where known, possible interaction or interrelationships with other technologies and practices were identified.

All of the technologies chosen for examination are currently in use in remote tourism facilities, or would be likely to be used in such facilities, or appear to be feasible for such facilities. Technologies which were contrary to the study goals or not yet commercially developed were not considered.

Abbreviated lists of suppliers and sources of information have been provided in appendices to this study.

ENERGY SOURCES AND SYSTEMS

This category was based on information on technologies and practices which are typically used in the alternate energy industry.

This category includes **renewable energy sources** (wind, photovoltaics, active solar, hydroelectric, battery cycle charging and combinations of these with or without conventional generation sources) and energy sources such as **cogeneration** and **wood heat.** **Energy efficiency** technologies and measures such as waste energy recovery, lighting, appliances, heating, load management, transport, and building efficiency were examined and summarized in the matrices.

It was concluded that current facilities should reduce energy loads to a minimum and implement all measures which are both appropriate and cost effective . It was also concluded that for proposed facilities, available and existing energy resources be evaluated and the various generating alternatives be examined, understanding that alternatives need to be considered during all the planning, design and operating phases of a facility.

WATER AND SEWER MANAGEMENT

For the purpose of this study, the water and sewage management technologies were categorized into three basic areas:

- Water Source and Treatment
- Water Conservation Technologies
- Sewage Treatment Systems

Water source and treatment includes the options for a raw water source and systems for treating raw water for potable use. Water conservation technologies include an overview of fixtures, plumbing systems, and management techniques which reduce flows or overall consumption of water. Sewage treatment systems include technologies aimed at both the treatment of grey water and of black water effluent generated by active-use facilities.

The site specific information and testing required to determine applicable alternatives were reviewed in this study. A variety of technologies were reviewed in three categories. **Water sources** include wells, surface supplies, rainwater collection and water hauling, and **water treatment technologies** include disinfection, various filter systems and packaged water treatment plants. **Water conservation technologies** reviewed include retrofit devices (such as low flow shower heads and toilet dams), and water re-use and re-cycling systems. The

sewage treatment technologies reviewed range from pit toilets, septic systems, storage systems, and composting systems, to lagoon and spray irrigation systems. Also reviewed are emerging technologies such as rotating biological contactors, passive multi-component systems and 'living machines'.

It was concluded that for proposed facilities: detailed site specific analysis and assessment be performed, including discussions with regulatory bodies; simple, basic and passive technologies should be considered first even if initial capital costs seem higher; unproven systems should not be used unless small scale pilot studies have been performed; and natural systems such as wetlands should be utilized, if possible.

WASTE MANAGEMENT

The significant activities and their corresponding waste streams have been identified in the context of the two example facilities. An appendix is provided which details a variety of options for minimizing and dealing with these waste streams. The relative priority of the four principles of waste management programs is identified, with **reduction** having highest priority, followed by **reuse**, then **recycling** and finally energy **recovery**.

Specific management strategies in six areas are discussed. **Purchasing** strategies include: elimination and substitution, bulk purchasing, packaging reduction, linking purchasing and recycling, and purchasing durable/reusable/recycled goods. **Material storage and handling** includes storage and spill prevention strategies. **Waste storage and handling** includes strategies such as: source separation of wastes, waste transportation, cooperative waste systems and waste disposal. Other areas include **equipment maintenance and handling** through preventative maintenance and quality control strategies, the **minimization of the use of materials** and **client education**.

Four waste management planning priorities were identified:

- Reduction in materials imported to the facility
- Reduction in the amount of material generated at the facility
- Maintenance of the quality of used and residual materials
- Reduction in the weight and volume of materials which must be removed from the facility

Waste minimization recommendations include: client education, reduced material importation, and the use of local community programs and suppliers. It was also recommended that the facility planning consider storage, material handling, and a transport plan.

LIFE CYCLE COSTING

It is useful to compare the life cycle costs of potential scenarios so that the potential user can project the actual costs over the lifetime of each scenario. In this manner an **useful comparison** on an equal basis can be made. Life cycle costs take into account interest rates, return on investment and inflation rates. This can be used to help the planner choose the most cost-effective integrated system for a given facility. As well, this methodology can be used to compare individual alternatives or the relative costs of changing or not changing an existing system.

In performing this analysis it is critical that all technologies and options are treated in the same manner, all costs are included for each, and that all inter-relationships are accounted for, otherwise the results will not reflect the true life cycle costs.

Life cycle costs do not account for non-monetized parameters that may be important such as environmental and social externalities. Environmental benefits may or may not actually have a cost savings to them but may be important to the operator of a facility or to development authorities. Similarly, as the facilities are tourism based, it is also important to consider effects on occupancy rates (which are not included in the analysis).

In summary, life cycle costing analysis can be used to **assist** the decision making process but should not be used as the sole decision maker.

GENERAL

The previous comments relate to specifics of technologies. The following are more general conclusions.

- operators of existing facilities should be encouraged to undertake an enevironmental audit of their operation.

- it is important that relevant existing and new information produced by government, such as Alberta Environmental Protection's Action on Waste Program, is well circulated and accessible to current and potential lodge operators.

- any actual implementation of a retrofit or a new facility based on the examples indicated in this study (whether initiated by private sector, academia, or government) would provide valuable information to all parties, by demonstrating the decision making process and the real life practicalities of implementing alternative technologies.

- developers and operators should be encouraged to look at low impact alternatives as part of their business or development plans, and consider implementing those which are demonstrated to be feasible.
- the constraints of the study budget were such that alternatives in 'conventional' fossil fuel based generation were not examined. However, there are various alternatives which may reduce impact, relating to fuel type, sizing, controls, multiple unit synchronization, etc. Further examination of these alternatives would be beneficial.
- developers and operators would find it beneficial to assess site specific renewable energy resources to determine the potential and feasibility for use.
- the establishment of permit and inspection requirements for remote facilities utilizing alternative energy systems, combined with education of the inspecting authorities as to the current state of the technology, would expedite facility planning and development. For example, at present there are no clear codes and/or accepted practices for solar (PV) installations, and many inspectors have never dealt with DC power systems or the specialized components which are not common to conventional systems.
- the implementation of small scale projects using some of the emerging water and sewage management technologies discussed in this study would be a very effective way to provide evaluation information for regulatory bodies and developers of remote facilities
- documented examples of lodge operators who have implemented successful waste minimization alternatives would assist other operators who may consult them for advice.
- the development and implementation of waste

management plans would be beneficial to build into new lodge developments, as well as existing lodges.

- the development of a generic life cycle costing model, with spreadsheets, that can be easily used by remote facility operators in their planning and decision making process would be extremely helpful.

2.0 Introduction

2.1 Purpose

Tourism both depends upon, and affects the quality of the natural environment. Tourism also represents a potentially valuable instrument for sustainable development, combining economic opportunities with environmental conservation and enhancement activities, and promoting environmentally and socially responsible attitudes and behaviour.

In Alberta, proposals for new tourism operations in remote and unserviced locations are under consideration. These may be located in sensitive environments. There is concern by the public, agencies and the industry, that developments should be appropriate to the environment in which they are proposed, and that they reflect sensitivity for the environment in which they are located. The public, in particular, is concerned about such systems as energy and water use, and waste and sewage disposal.

Alberta Economic Development and Tourism, as part of a series of initiatives which recognize the importance of environmental resources, has commissioned this study. This work provides information which demonstrates the range and type of environmentally responsible approaches to planning, design, construction, equipping, and operation of such a facility, by reviewing the technologies available in three broad categories: energy, water and sewage, and waste management. In each category, recommendations are made for the most effective approach to selecting or utilizing various practices or technologies. A discussion on life cycle costing and its inherent limitations is also included.

2.2 Methodology

A team approach was adopted to provide expertise in each of the broad categories. Nor'wester Energy Systems Ltd. (Nor'wester) acted as team leader and provided expertise in the energy category. MPE Engineering Ltd. (MPE) provided the water and sewage expertise. Waste management expertise was provided by Willow Root Environmental Ltd. (Willow Root). Based on the two example facilities given in the Terms of Reference for the study, a review of applicable technologies and practices was performed by each team member for their area of responsibility. A short description of each technology or practice was then prepared. The two example facilities were:

- a stand alone lodge which would accommodate 25 people, including staff
- a lodge with family unit cabins, to accommodate a total of 60 to 70 people, including staff

A matrix was developed with input from the team members and Alberta Economic Development and Tourism. The matrix gives brief details for each technology/practice as to feasibility, costs, advantages and disadvantages, various impacts/benefits, etc. An attempt was made to ensure that any possible interaction or interrelationships with other technologies and practices were identified.

For the most part energy sources and systems are technology based, although there are some aspects which are practice based (particularly load management). Therefore a straightforward process of selecting those technologies and practices which may be relevant in terms of the two examples given was followed. Evaluation of the technologies and practices was then performed by utilizing the matrix. Almost all of the information required for the energy section was available in-house by Nor'wester through its own library and project experience. The information that was not available in-house was accessed through Nor'wester's established information network. An important part of the work was to establish the interactions between the technologies within this category and the technologies and practices of the other categories.

Water quality and conservation systems are also generally technology based although they may be influenced by practices and technologies in the other two subject areas. A similar methodology as described above was followed for this section. Again much of the information required was available in-house at MPE. Information that was required outside of MPE's experience and internal resources was researched through computer based international information networks.

The approach to waste management by Willow Root was to identify a combination of waste management practices and technologies which are appropriate in the remote tourism operations described. The waste management section takes the form of identifying a generic waste management strategy for the facility operations supported by appropriate waste management technology. While a generic waste management strategy is recommended, the information represents more of an initial menu from which operators may choose. The specific waste management technologies and practices applied to any given operation will ultimately vary according to operating conditions such as economics and logistics. Waste management has also been tied to the technologies for water and energy conservation.

In order to perform realistic cost comparisons a simple methodology was developed, based on previous work, for determining life cycle costs which can be applied to specific applications using the information provided in the matrix. Life cycle costing takes into account the installation, operation and maintenance of a system, as well as the time value of money, and therefore allows a fair comparison between systems or combinations of systems. This will allow planners to make an informed decision as to the most cost-effective system for a given application.

Conclusions are given for each sector during the compilation of information. General conclusions are presented at the end of the report.

2.3 Notice

As discussed in section 2.2, this work has been done based on current knowledge gained from direct practical experience and applications. There are a wide range of variations in all of the technologies and practices discussed in this document, and there are even wider ranges of remote tourism sites and situations. As such, the results and overviews must be viewed and interpreted with specific limitations and advantages for each application in mind. Certain of these are described specifically, as follows.

All technology costs shown herein are 'order of magnitude' values, and readers are cautioned that costs will vary with such variables as region, dealer, brand and model, as well as needs and practices (eg. obviously a small energy load can be satisfied with a low cost system, however the same technology would cost much more when supplying a larger load).

Throughout this work, the two example facilities cited in Section 2.2 are kept in mind. Facilities which are quite different from these may find improved or poorer results from those suggested. In any case, many technologies are very site specific, and therefore are not applicable to all possible facility locations. Similarly, life cycle costing may not be precise or even possible for some technologies, and more detailed work for a specific establishment will be required.

It is a fact that many codes, standards and regulations are best interpreted with the experience of the appropriate inspectors, however many of the technologies and practices herein are outside the experience of many such professionals, and some do not fall under current codes and standards. It may therefore be appropriate to introduce authorities to new practices with well thought out and researched background material, so that they understand them, in order to benefit the facility operator, the environment, and public safety.

3.0 Energy Sources and Systems

3.1 Introduction

The energy sources and systems were developed from information on technologies which are used every day by Nor'wester Energy Systems. The information sources included work experience and practice, as well as supplier and product files. All of the technologies chosen for examination are ones which are currently in use in remote tourism facilities, and would be likely to be used in such facilities, or appear to be feasible in such facilities. Keeping in mind the purpose of this work, technologies which obviously were contrary to the study goals or not yet commercially developed were rejected for consideration (for example: the 'nuclear battery', tire burning, hydrogen fuel technologies).

3.2 Technology Overview

This section gives a summary description of the technology of each energy source or efficiency measure, and discusses where applicable the relationships with other technologies and practices.

3.2.1 Energy Sources

Only alternatives to conventional fueled energy sources are discussed in this study. There are also, however, potential energy savings and environmental impact reductions possible with different technologies or fuels and practices in the conventional fuel technology area. However these are beyond the scope of this study.

.1 Wind

The use of wind energy technologies can include: **electricity generation** for any purpose, **water pumping** by mechanical means, or **aeration of water** (including waste water) by mechanical means. Electrical systems are those which convert the energy of the wind to electricity where the wind causes a rotor (typically 2 or 3 blades) to rotate which in turn spins an electrical generator. Mechanical systems are those where the energy in the wind is directly converted to mechanical energy such as pumping or grinding. In this case, as the rotor (typically multi-bladed) is turned by the wind, a mechanical system (such as a pump) is caused to operate.

These technologies require a site with good wind resources available at times when loads require this energy, although energy storage is available in several forms. Mechanical systems, although 'stand-alone' in operation, work well with other technologies such as water supply systems and waste water treatment systems. Electric systems are generally compatible with other forms of generation, usually interfacing through battery storage and electronic control or conversion components. Generation capability applicable to this market ranges from 50 watts to multiple units of 10 kW size, in voltages from 12 to 120.

.2 Solar

Solar energy technologies occur in significantly different forms, ranging from **electricity generation** (photovoltaic or PV) to **water heating** or **active solar** (passive solar space heating is treated under Building Efficiency). Solar here refers to direct use of sunlight striking a surface to generate electricity or produce heat.

Solar electricity generation: In the case of PV, the solar panel material made of silicon and other materials generates direct current electricity in sunlight. This electricity is used directly for **water pumping** or **aeration**, or stored in batteries for any use. PV is available in modular form starting at a few watts, and may be built up into systems of almost any size, in multiples of 12 volts.

Solar water heating: This an 'active' system of pumping a fluid through solar panels which contain black piping which heats the fluid in the presence of sunlight; the fluid may be directly used if it is water, or the fluid may be used to heat water in a hot water tank through a heat exchanger. The fluid is moved by electric pump. Solar water heating is usually used as an add on to reduce water heating loads by other means (wood, electric, gas), but it may also be the sole source of heat for water.

.3 Hydro-Electric

Hydro-electricity does not require large dams and water storage for small scale electricity generation. There is a wide range of low head, 'run of the river' products which have low impact and are cost-effective. Mini- and micro-hydro systems range from low wattage (100 to 1000 watt) battery charging systems to 60 Hz alternating current systems capable of up to 100 kW or larger. Access to high flows and/or significant head (drops) are a requirement, but this technology is very effective and reliable.

.4 Battery Cycle Charging

This technology is typically a standard component of Wind and PV technologies, as well as some micro-hydro, but in this category refers to its application to fueled generation systems. Generator sets are automatically operated at rated output for a modest time period to charge up a battery bank, then shut down while loads operate off the batteries, using an inverter to supply AC energy. When the bank capacity drops, the generator is restarted and the cycle repeats. The results of its use include reduced maintenance, reduced fuel costs, less operating noise, fewer emissions, more efficient operations. This technology is easily applied as a retrofit to existing facilities. This technology is best employed where alternate energy sources cannot be used or where they are insufficient to supply all electricity needs.

.5 Hybrid Systems

Hybrid systems are those which combine any or all of wind, solar, hydro and cycle charging with or without a fueled generator set (gas, diesel, propane). The variations are endless, but primarily a hybrid system takes advantage of the relationships among available resources to optimize energy generation. Some systems may use wind and PV where weather patterns complement each other; other systems may use micro-hydro with a cycle charge system to extend battery operations and further reduce generator operations. Systems may be very simple, or quite complex. This category of systems is likely to be the most common in the future.

.6 Combined Heat and Power/Cogeneration

Combined heat and power (CHP), and cogeneration (cogen), are closely related. In all cases, electricity is generated, and heat (heated air, heated water, or steam) is generated. Some units are primarily power, others primarily heat. In all cases, the overall efficiency of obtaining both products is increased. These systems can be as simple as piping available hot water from the powerhouse into the lodge facility, or as complex as can be imagined. These technologies work best for facilities with constant needs for power and heat, and where the operation of a single unit is more efficient than operating two independent systems.

.7 Wood Heat

Wood heating is almost synonymous with remote tourism, but the technology has become very sophisticated recently. Wood heat in its simplest form now uses airtight, high efficiency woodstoves, often with glass doors for visual effect. These units are much more efficient than fireplaces or unsealed stoves, although they require knowledgeable operation. Pellet stoves use waste wood (sawdust) and meter the fuel according to temperature settings, from a fuel hopper. These units are extremely efficient, and highly regulated, without compromising the visual effect of the woodstove. Wood burning fireplaces may use logs, pellets, or have dual fuel (gas, oil) capabilities; pellet versions are the most efficient and easy to operate, due to their precise fueling capabilities. Many modern wood heating appliances require constant sources of AC electricity to operate correctly, or at all - this may affect choices and costs of electricity generation sources.

3.2.2 Energy Efficiency

.1 Waste Energy Recovery

Waste energy recovery is capturing or retaining excess heat energy for other purposes or re-use. Examples include **engine heat recovery** in the case of a diesel generating set (ducting heated air from powerhouse to lodge, or **pre-heating domestic hot water** using a water jacket and heat exchanger), **recovering heat** from used hot water (dishwashers, clothes washers, etc.), or routing vented hot air from a clothes dryer through a **heat exchanger** in an adjacent room. This category also includes **insulation of heating appliances**, such as hot water tanks, hot tubs, ovens, etc. Most of these methods are inexpensive, simple, and effective.

.2 Lighting

Lighting is a highly visible form of energy use and is therefore relatively easy to address by habit or practice. Energy use can also be reduced through **controls** such as dusk sensors, occupancy or motion detectors, use of more **efficient fluorescents or PL lights**, and enhancing the use of **daylight** to reduce or eliminate use of artificial lighting in daytime. For systems which store energy in batteries, use of **DC lighting** can mean greater efficiency, since energy is not lost in the use of an inverter. Installing the correct luminosity for the situation, reducing lighting in areas where possible, and turning off lights when not needed are the key to efficiency.

.3 Appliances

The use of **efficient appliances** can make a big difference in remote tourism facilities, even to the point of requiring electricity where it previously was not used. Refrigeration is a large energy user, but all appliance use adds up. The key is to choose appliances that fit the requirements with the greatest possible efficiency. In some facilities the use of **gas ranges, dryers** and refrigerators may be more efficient than electricity powered units. DC refrigeration units are available with extremely high efficiency, albeit at a higher than average cost - which may outweigh efficiency advantages.

.4 Heating

Energy efficient heating includes **temperature setbacks** (manual or automatic), for **air and water heating,** use of **low flow tap and shower heads** to reduce use of heated water, use of electric **heat pumps** in facilities where both heating and air conditioning are needed, and use of **high efficiency furnaces** in lieu of 'standard' ones. This category ties in closely with building efficiency.

.5 Load Management

Load management is divided into two areas for clarification, based on the 'hardware' to manage energy, and the habits or practices of managing energy.

Energy Management Systems

This area includes a full range of semi to fully automated systems, ranging from analog clock thermostats, through priority load shedding (turning off lower priority loads when advantageous), to fully digital control systems with power factor correction (see below). The ability to use these and the cost-effectiveness of them will depend upon each facility, and whether construction is new or a retrofit.

Energy Management Practices

This area is based on 'common sense' and 'good habits', and includes such practices as manual temperature setback, reduction of appliance usage (eg. one full dishwasher load rather than three small ones), drying laundry outside on nice days, restricting use of hair dryers, etc.

Power Factor Improvement

Put simply, the power factor is the ratio of usable electric energy from a generator to the energy produced. Motors and unbalanced loads may reduce this ratio and thus the system efficiency. Various means can be employed to improve the power factor including power factor improvement motors and load balancing. This technology can be of significant advantage for three phase electrical systems (typical of larger diesel or propane generator sets) on which mostly single phase loads are operated. These systems are very susceptible to load imbalance. It is easiest to implement on new facilities, and can be expected to save considerable energy by significantly improving energy efficiency on these loads.

Energy Efficient Motors

Purchasing optional energy efficient motors in new equipment (pumps, fans, etc.), or replacing old ones is a straight forward and cost-effective measure which improves performance and saves energy.

.6 Transport Efficiency

Transportation into remote facilities is extremely time and energy consuming. Methods to improve this area include **reduction of motorized and air transport** (increased use of horses, skiing, hiking), and improved scheduling with optimization, to ensure that each trip is made as efficient as possible and that the number of trips made is absolutely essential (eg. a single saved helicopter trip may equal many days of lighting efficiency). Good communications obviously plays an important role in this.

.7 Building Efficiency

Building efficiency relates in many ways to all of the categories above, since the building houses and delivers the technologies. The basic tenets of efficient building construction are based on high quality **airtightness**, coupled with efficient **air to air heat exchangers** to remove water vapor and contaminants. Additional **insulation** in walls, ceilings and floors, use of 'airlock' entrances and **high technology windows** are becoming more commonplace. The use of move-able insulation, such as window **shutters,** greatly increases heat retention. For new buildings, and to a degree for retrofits, **passive solar**

designs - particularly those which incorporate thermal storage and associated techniques - are a no or low cost way to increase building efficiency. Passive solar design features include south facing windows, little or no north facing windows, building into south facing slopes, incorporating thermal mass into the design (concrete, masonry, water or rock), protecting entrances and a host of other design features.

3.3 Technology Summary

The detailed summary and evaluation of all technologies in this category is given in a matrix format in Table 1 of Appendix A. These technologies are all suitable (in some form) for both of the example facilities, the stand alone lodge and the lodge with cabins.

3.4 Conclusions

For an **existing** remote tourism facility, the following steps are recommended:

- Perform an energy audit (heat and electricity) of the facility
- Reduce electricity and heating loads to a minimum using the energy efficiency measures notes; as a guideline all measures which are applicable and have a two year or less payback could be implemented without further consideration.
- Once loads are reduced, evaluate existing energy resources (hydro, wind, solar) for applicability. **Renewable energy options are generally more applicable to modest loads.**
- Then, evaluate the alternatives for generating electricity, using renewable energy resources, hybrid systems, or cycle charging from a fueled generator set.
- In parallel, implement transport techniques.
- In parallel, use other energy efficiency measures to evaluate reduced non-electric loads, for example evaluate any wood heating appliances for applicable alternatives.

For a **new** tourism facility:

- In parallel, evaluate existing energy resources while planning facility loads.
- Then, evaluate the alternatives for generating electricity, using renewable energy resources, hybrid systems, or cycle-charging from a fueled generator set.
- Most energy efficiency measures cost much less and are more

effective when installed during initial construction compared with retrofit costs; applicable measures should be included in planning of new facilities.

General recommendations include:

- Current standards, codes and inspection requirements should be determined before making any changes to facilities or when planning new facilities. If the appropriate authority is unfamiliar with the technology in question, steps should be taken to provide the authority with full information and to work together with the authority to implement the technology in a safe, useful and cost effective manner.

- This study has not examined the different technologies, fuels or practices in conventional fossil fueled generation as this is beyond the scope of this document. However, these should be fully evaluated as part of the decision making and planning process.

4.0 Water and Sewage Management Technologies

4.1 Introduction

Water and wastewater treatment systems which are sensitive to the surrounding locale are critical to the successful development of remote lodging facilities. For the purpose of this study, the water and sewage management technologies have been categorized into three basic areas:

1) Water Source and Treatment
2) Water Conservation Technologies
3) Sewage Treatment Systems

Water source and treatment includes the options for a raw water source and systems for treating raw water for potable use. Water conservation technologies include an overview of fixtures, plumbing systems, and management techniques which reduce flows or overall consumption of water. Sewage treatment systems include technologies aimed at both the treatment of grey water and of black water effluent generated by active-use facilities. While many of the preceding technologies have been proven over time and numerous applications "in the field", there remain in some categories a number of emerging technologies which are very promising, but are either in the development phase or are relatively unproven in large scale application. In some cases, time did not permit a detailed review of these techniques but they are noted in the appropriate matrix for reference.

The water and wastewater systems review and analysis focuses on two basic remote site development scenarios as discussed in Section 2.2 (Methodology):

- a stand alone lodge which would accommodate 25 people, including staff
- a lodge with family unit cabins, to accommodate a total of 60 to 70 people, including staff

From a water distribution and treatment standpoint, the stand alone lodge is characterized by a single system serving a single facility, whereas the physical separation of a lodge with family unit cabins will dictate a water distribution and wastewater collection system or individual treatment systems in each unit. Both facilities are assumed to require full toilet and bath facilities, as well as communal kitchen and cooking facilities. Based on fully serviced facilities and assuming no conservation techniques are employed, water consumption and sewage generation rates in the order of 11,300 litres (2,500 Igal) per day for the 25 person facility, and 31,800 litres (7,000 Igal) per day for the 70 person facility can be expected. Conservation techniques can result in minimal to significant reductions (0-90%) in these figures, depending on the techniques employed and the water use/sewage production characteristics of the facility.

The overall methodology of this section included an initial review of various alternative technologies, a brief review of technical documentation, discussions with both suppliers and contractors relative to "order of magnitude costs", and completion of a matrix highlighting the component characteristics of each technology. Due to time constraints and the non-site specific nature of the study, detailed and in-depth analyses of each alternative were not performed. Rather, this study centers on identifying alternatives and then presenting general information which allows overall comparison of alternatives and provides a basis for more detailed future feasibility investigations.

A range of costs are presented, generally corresponding with the 25 and 70 person scenarios. For some technologies, the size of facility is much less of a factor in determining the overall costs than some of the more site specific characteristics. For instance, the costs associated with drilled wells will be largely dependent on the groundwater depth and flows. As such, the drilling costs and well yield can vary widely such that in some areas one or two wells may be more than adequate to supply the maximum daily usage in either the 25 or 70 person facility. In other areas where the groundwater conditions are less than ideal, the yield from multiple wells may be insufficient over the long term to even support the smaller facility, and may require additional pumping and storage facilities or supplementary sources. As can be expected, costs can vary widely depending on other site specific characteristics such as soil conditions, site accessibility, distance to major centres and transportation routes, access to surface water, continuous or seasonally intermittent operation of the facility, size of the facility, and the degree of environmental sensitivity. Where possible, the major factors influencing the cost and feasibility of each technology are identified.

A matrix has been produced for each of the three categories outlined earlier. Within each category are a variety of technologies which may or may not be applicable in all situations. The most appropriate alternatives for any particular site would be generated only after gathering more site-specific information. It is likely that some technologies may be completely inappropriate for some sites, yet feasible for others. A summary of the matrix information is provided in Table 1, which outlines the major variables influencing the "best use" technologies for any particular site.

4.2 Technology Overview

This section will summarize the specific technologies associated with each of the three categories outlined in Section 4.1. In general, for all systems being investigated, the most appropriate technology will not necessarily be the lowest capital cost alternative. Ongoing operation and maintenance costs as well as local acceptance by the regulatory authorities can often dictate the feasibility of the alternatives. Incoming raw water quality and outgoing effluent standards will also be strong determinants of the most appropriate technology on a site by site basis.

Prior to choosing any particular technology, a variety of site specific information should be gathered. Such preliminary information would include:

- **Geographic** - distances to major transportation and surface water sources; site elevations; topographical surveys;
- **Vegetation** - surveys of the vegetative cover including trees and grasses;
- **Soils** - review maps of the soil types especially as they relate to water percolation and infiltration rates and construction parameters (eg. hard rock versus soft soils);
- **Groundwater** - review of groundwater mapping and well record information in the area;
- **Regulatory** - review of the area with both local and Provincial regulatory bodies especially with respect to stream flows, other users on the streams, protected fish and animal habitat, and allowable withdrawal and effluent discharge;
- **Related Experience Parameters** - review of the local sites or similar sites outside the local area for general guidance in choosing the most effective technologies.

A review of this preliminary information would eliminate a number of alternative technologies. Additional detailed testing and analysis would further clarify the more appropriate options. While this would require additional expenditures, it would provide invaluable information and might include:

- **Surface Water Quality Tests** - in surface water sources, laboratory tests for chemical and bacteriological parameters and

turbidity would clarify the extent of treatment required and the most appropriate treatment method; in receiving streams, water testing would clarify the impact of the effluent discharges;
- **Groundwater Testing** - at sites where groundwater is expected to be adequate, drilling wells would allow for the calculation of yield and provide water samples for chemical analysis and any treatment requirements;
- **Soil Percolation Tests** - at sites where septic tile fields would be considered as an option, percolation tests must be carried out on the soil to measure its adequacy at accepting effluent discharges;
- **Biological Inventory** - receiving steams and the proposed site would be surveyed for fish and wildlife habitat to assess the impact of water withdrawal and effluent discharge techniques;
- **Pilot Studies** - when a number of individual facilities are planned within a general area, it may be advantageous to carry out pilot studies on a few of the initial sites; each site may utilize a different technology and new sites could be developed based on the performance of these pilot sites; the assessment criteria would include capital costs, operation and maintenance involvement and costs, ability to meet regulatory standards, impact on the site environment, reliability and any other pertinent criteria.

Pilot studies would primarily focus on the wastewater treatment methods which generally have the greatest potential for environmental impact on remote sites. In certain circumstances, pilot tests on water treatment methods can also be considered. For example, the sensitivity of reverse osmosis and "nana" filters to chemical components in the raw water means it may be useful to test such systems with actual site raw water to determine the pre-treatment requirements and minimize expensive membrane replacement. Consulting firms, suppliers, and the regulatory bodies familiar with wastewater systems can assist in setting up such pilot projects.

In general, the main regulatory body responsible for the approval of water and wastewater treatment systems in Alberta, outside of the National Parks boundaries, is the provincial department of Alberta Environmental Protection. Alberta Labour also becomes involved in any project, administering the plumbing and on-site regulations. At the local level, municipal and parks personnel will have input into the approval process and will typically issue any required building permits. In this section, references are made to Canada's National Parks and their experience with remote site water and wastewater systems. These are included for discussion purposes to illustrate the performance and acceptance of various technologies by Parks Canada personnel, though in all instances, they may not reflect the unique opinions and experiences of municipalities and Provincial Parks Services outside the National Parks boundaries.

4.2.1 Water Source and Treatment

.1 Water Sources

The two most important factors in assessing the feasibility of a raw water source are quantity and quality. These will determine the requirements for storage and treatment respectively. The source of raw water for potable use can vary widely, to include traditional sources such as **drilled underground wells** and **surface supplies** from creeks, rivers, or natural impoundments such as ponds and lakes. Alternate raw water sources such as **rainwater collection** systems can be effective, but due to the seasonal nature of rainwater, lined impoundment areas or tanks must maintain the supply through the winter months, and as such these systems are often considered supplementary at best. **Fresh water hauling** into remote site cisterns is another option, though the high energy consumption and costs of transport make it less desirable. In some cases, the costs of hauling water to a site can be offset by the need to haul wastes off-site.

In order to meet peak hourly demands for water, the water source should be able to supply 0.75 to 1.15 l/s (10-15 Igpm) for the 25 person facility, and 2.25 - 3.0 l/s (30-40 Igpm) for the 70 person facility. For well yields or water source flows less than this, storage facilities would have to be considered. Any water source should provide at least the average daily demands of 0.08 - 0.15 (1-2 Igpm) for the 25 person facility and 0.23 - 0.38 (3-5 Igpm) for the 70 person.

.2 Water Treatment

Due to the site specific nature of the raw water source, water analysis must be carried out prior to deciding on any one particular treatment technique. Elevated levels of inorganics such as iron, manganese and calcium/magnesium hardness are common to groundwater sources, while high turbidity from suspended inorganics are common to surface impoundment waters. Removal of such impurities as well as disinfection of water for potable use remain the main focus of modern water treatment techniques. Coagulation, flocculation, clarification, filtration, chemical removal including iron and manganese removal, pH control, softening, taste and odour control, and disinfection remain the most common unit processes in water treatment systems in Alberta. **Disinfection** by chlorine gas and chlorine compounds is prevalent due to the need for residual disinfection in the distribution system. Ozone and ultra-violet irradiation disinfection are less common due to the inability to maintain such a residual and as such must be used with chlorine disinfection. In point-of-use applications, U.V. disinfection may be used without chlorine.

In montane regions, treatment systems are often less intensive as surface waters are typically low in turbidity, dissolved solids and organics. Further downstream outside the montane areas, the drainage basins typically include silty, organic soils and agricultural land uses which increase the turbidity and the level of treatment required.

The water treatment options outlined in this study focus on the treatment of groundwater and surface waters. **Small multi-media filters** utilize sand or granular filter media in small cylindrical pressure tanks that can be connected in series and housed within the lodging facility. In general, the use of multi-media pressure filter systems as stand-alone systems using surface water sources are becoming less common especially since the regulatory body (Alberta Environmental Protection) has determined such systems may not effectively remove the *Giardia lamblia* cyst which can be carried by mountain streams. Such systems are often used as pre-treatment for reverse osmosis and "nana" filters which can remove the cysts, or with groundwater sources where *Giardia* is not a concern. **Slow sand filters** utilize a large area sand filter typically housed in a separate concrete tank through which raw water slowly flows and is treated via a biological layer, or "schmutzdecke" which develops on the top of the filter. **Filter membrane systems** such as used in reverse osmosis systems and "nana" filters utilize membranes with small (1 to 2 micron) openings in special cylindrical units. **Package water treatment plants** are typically steel or aluminum units which incorporate rapid mixing of coagulants, settling clarifiers, and rapid sand filters complete with air scour and backwash capabilities.

4.2.2 Water Conservation Technologies

.1 Retrofit Devices

A significant number of water conserving **retrofit devices** have been developed to fit conventional plumbing fixtures and are readily available commercially. Tate (1990) estimates that in a typical household which does not require lawn watering, 79 percent of water consumption is attributed to the bathroom toilet and bathing fixtures, with 14 percent to laundry and only 7 percent to drinking and cooking. Many of the water saving devices occur in the bathroom facilities and include toilet dams and dual flush mechanisms, low water consumption toilets, low flow shower heads, thermostatic or pressure balancing mixing valves, faucet aerators, and pressure reducing valves. A number of less conventional systems are also available such as vacuum assisted toilet systems, pressure tank toilets, and composting systems.

While a number of these systems do conserve both water and heating energy, some agencies (NWT 1994) have determined that retrofit devices such as toilet dams and existing tank modifications perform less satisfactorily than devices designed specifically for conservation. For example, conventional toilets designed to operate with high flush volumes do not always operate as effectively with reduced tank capacities and may require a second flush; when the flow is reduced conventional shower heads will often not deliver a water stream which is currently acceptable to uneducated users. For new facilities and retrofits, toilets and shower heads designed specifically for water conservation are better received by both users and maintenance personnel.

.2 Water Re-Use and Re-Cycling

A second conservation component includes **water re-use and re-cycling devices**. Such devices include **grey water systems** which store waste water from sink and bath fixtures in a tank system and re-pump the water for use in toilet flushing. Other similar systems separate grey water from black water for separate treatment of each. Due to the relative availability of good water sources in Alberta and the relatively high costs associated with the mechanical installation and operation, grey water systems are not common in Alberta. Still, such systems may be considered alternatives in facilities where the water source is extremely limited and the higher costs may be justified.

Due to the large number of water conservation technologies and the limited scope of this study, the reader is directed to Cameron and Armstrong (1994) for an excellent summary of numerous water saving technologies applicable to remote sites in the Northwest Territories.

.3 Compatibility with Other Technologies

Water conservation devices must be assessed in the overall context of the potable water source and the wastewater treatment system. Water conservation devices can indeed reduce the treated water consumed, but can also increase the concentration of effluent wastes and in some cases reduce the flow capabilities of collection systems. Increased effluent concentrations can require increased sewage treatment such as multi-stage or series digesters. Again, these must be looked at on a site specific basis.

4.2.3 Sewage Treatment Systems

.1 Treatment Systems

The greatest challenge in providing water service to sensitive, remote sites remains the effective treatment of sewage wastes to allow for return of the effluent to the receiving stream or recycling in a facility's sewage system.

The major constituent of raw sewage is water, comprising more than 99 percent of the influent wastewater. A diverse number of impurities exist in raw wastewater, many being solids which remain as residue after evaporation. Removal of such impurities as well as reduction in fecal coliforms and pathogenic bacteria in effluent streams remains the basis of modern sewage treatment.

The removal of inorganics such as nitrogen and phosphorous compounds is important to prevent eutrophication (excess growth of algae) and the formation of ammonia which can be toxic to fish and reduce the efficiency of chlorine disinfection. The most common indicator of organic compounds remains the biochemical oxygen demand, or BOD. The results of BOD tests on effluent can be used to determine the approximate amount of oxygen required to stabilize the organic matter. BOD tests on effluent from facilities similar in nature to a proposed facility can be used as a guideline to estimate the required size of a treatment facility. Other effluent indicators which influence the type and extent of sewage treatment include chemical oxygen demand (COD), oils and grease, alkalinity and pH, chlorides, sulphur compounds, and trace metals. These are provided for general reference and will not be discussed in detail in this study.

The **septic tank and tile field** is a traditional system, and can be restricted by poor ground conditions, a high water table, and physical space or aesthetic restrictions. Tile field lengths to service 25 to 70 people on a continuous basis could be 1,200 metres to 2,500 metres, and so make a significant impact on sites where altering the landscape is not acceptable. In addition, the performance of septic tank and tile systems have not been acceptable to National Parks personnel.

Consideration is now being given to separation of grey water and urine for sub-surface treatment with black water being directed to **holding tanks** and transported off site. At many sites in the National Park System where septic fields are not suitable, it is not uncommon to collect all wastes in a holding tank system and fly out the effluent via helicopter on a daily basis (eg. the Teahouse at Lake Louise). Some newer designs reduce held wastes, thus flyout frequencies may be as infrequent as once a year (eg. Alpine Club of Canada).

The **exterior pit toilet or "outhouse"** is another traditional alternative which has been successfully used in many applications. It has inherent odour, maintenance, and potential groundwater contamination problems in permeable soils. More recent **portable chemical toilets** have been developed, but require chemicals and periodic emptying of the toilet contents. In both cases, the unheated nature of these facilities makes them less desirable.

Composting toilet systems which can be integrated into heated structures have been developed to deal with the inherent problems of outdoor toilet facilities. To maintain the bacteriological process throughout the winter months, the composting tank should be within a temperature controlled environment. This can be achieved through an architectural design which incorporates a toilet above a heated basement or on an elevated floor a sufficient height above the ground to accommodate an enclosure for the composting tank. Discussions with National Parks Canada personnel reveal that potential maintenance problems with such facilities remain a concern.

More advanced sewage treatment techniques have been developed for small villages and developments, with varying degrees of success. Traditional clay or plastic lined oxidation ponds or **"lagoon" systems** are common among smaller communities and are quite effective for treating sewage effluent. Such lagoons are effective at reducing BOD, solids, and total nitrogen, and marginally effective at removing organic nitrogen and ammonia. While such lagoons are effective at treating sewage, long detention times of 7 to 12 months dictate large area requirements (0.4 to 1.2 hectares). The need for heavy earth moving equipment, expensive liners and large areas of land may make such facilities impractical at remote sites, especially in sensitive areas.

Extended aeration tanks can also be considered as an option, though the regulating agencies are hesitant to approve such facilities in sensitive areas due to the need for more frequent operator monitoring and the possibility of process upset and release of untreated effluent flows. For these reasons these systems are not considered in this analysis.

The most promising alternatives for remote sites include relatively small scale or **pre-fabricated units** which can be transported to site. **Rotating biological contactors**, or **RBC units**, have been used at a number of remote work camp and recreational areas. The RBC unit relies on a biomass forming on the large surface area of a specially designed disc which rotates in and out of the sewage. The biomass develops from seed microorganisms naturally present in the wastewater and is typically fully established after 2 to 4 weeks. Because these are continuous operation systems, the RBC can more readily accept large periodic loads without process upset or loss of treatment efficiency. Electrical energy is required with these units to continuously rotate the contact discs.

Passive multi-component systems utilizing combinations of relatively traditional technologies have recently been applied to relatively remote park sites in the Banff/Yoho National Park area. Due to the proprietary nature of the design, detailed information on performance and cost is not readily available. The technique utilizes an anaerobic upflow filter in a traditional septic tank followed by a slow sand filter. Although it has not been widely used, the technology has been gaining acceptance by Parks Canada personnel. The major advantage of such a system is low operation and maintenance requirements combined with the proven performance of its traditional components.

Another emerging technology developed in the U.S. and now on trial in two Ontario facilities ("The Body Shop" in

Toronto and Boyne River School north of Toronto) is the **"living machine" technology** which utilizes transparent tanks housing a diverse bacteriological and plant population within a controlled greenhouse environment. Raw sewage cycles through four sealed equalization tanks before being pumped into the tallest of 17 clear plastic cylinders which are arranged in a spiraling configuration. Gravity draws the water through the cylinders, then into a marsh for filtering and finally to a pond where there are native plants and animals. While the Ontario Ministry of Environment has not yet approved this method for return of waters to receiving streams, tests are ongoing. In Alberta, the technology has not yet been approved nor applied. The technology has developed with the "green" movement and requires little in the way of chemical and energy inputs. According to the manufacturer, the main advantages of this system is it offers very high standards of treatment competitive with conventional techniques of equivalent effluent standards, it is scalable from small to large facilities, and can extend the life of downstream tile systems or if disinfected, can be used for irrigation. In addition, the quality of the treated water is such it can be re-used in grey water systems to feed toilets and potentially reduce overall facility discharges to receiving waters by 90 percent.

.2 Effluent Release and Sludge Disposal

Downstream of sewage treatment processes, the treated effluent must be released. In many cases this means **sub-surface disposal** to a septic field, or after disinfection, typically by chlorine or U.V. light, to a natural watercourse. Where green space is present, another alternative is **spray irrigation disposal.** While such disposal is generally supported by Alberta Environmental Protection, spray irrigation on a continuous basis is not often favoured by National Parks administration in sensitive areas, as it tends to accelerate vegetative growth, though it has been used on a short-term basis where site reclamation was required.

Disposal of accumulated sludge in portable plants must also be carried out. Typically this involves pumping out of the clarifier into a tank for transport to a waste disposal area or treatment facility. Mechanical thickening devices can be used to reduce the volume of such waste, but can be relatively costly.

4.3 Technology Summary

As outlined in the previous sections, a matrix has been prepared for each of the main water and wastewater components discussed. The matrices can be found in Table 2 of Appendix A.

4.3.1 Costs

The matrices presented in this section represent generic overall characteristics of the most common and most applicable alternative technologies. The costs presented represent basic material supply costs to major centres such as Edmonton or Calgary. Transportation costs will be highly variable depending on location of the sites. Distance of the site from land transportation corridors will dictate any air transportation requirements. It should be stressed that air transport costs will not only vary with the flight time required, but also with the capacity of the aircraft. The following represents some hauling capacities and 1994 hourly rates (no GST) for helicopters:

Light Duty: 360 - 450 kg	$ 725/hr
Medium/Light Duty: 450 - 900 kg	$1000/hr
Medium Duty: 1700 - 2300 kg	$1910/hr
Heavy Duty: 2300 kg +	$3000/hr

Construction costs are also highly site specific depending on foundation materials, groundwater conditions, and transportation to the site. In many cases, water treatment facilities can be incorporated directly into the lodging facility. Engineering design costs have also not been included as they typically will be based on construction value and degree of complexity of the project. For budget purposes, it will not be unrealistic to use overall budget values in the order of 4 to 5 times that of the simple material supply costs to cover such items as heated enclosures, installation, transportation, and engineering. More accurate budget figures can only be provided through feasibility analyses on a site specific basis.

4.3.2 Regulatory Requirements

When considering the operation of water and wastewater facilities, it should be realized that provincial regulations require a license to operate. This license will typically outline the water quality sampling and disinfection monitoring periods. These can be as frequent as daily for large plants and weekly for smaller. As such, there will always be a requirement for an operator or a trained person responsible for the maintenance of the systems.

4.3.3 Facility Waste Generation and Product Usage

The technology review is carried out based on the assumption that the water and wastewater systems will be used by facility guests and staff in a manner similar to normal domestic households. It is assumed that toxic substances, such a petroleum products or cleaning agents which could potentially upset any natural biological processes, would not be introduced to these systems.

It is anticipated that guests would use typical toiletry products such as bath soaps, shampoos, and shaving creams. To reduce the loads on the wastewater treatment systems, soap products which limit the amount of nutrients, such as phosphates, should be promoted both for personal hygiene and facility cleaning requirements.

4.3.4 General Overview

Based on the information gathered in the matrices, the major factors influencing the appropriateness or "best use" of each technology is summarized in Table 1.

4.3.5 Water Systems Overview

When assessing water systems, those which can provide consistent treated water quality with minimal operation and maintenance should be considered first. On the smallest sites, cylindrical water treatment tanks may work very well but must be of sufficient size to handle higher turbidity levels. In the larger facilities, packaged flocculation, clarification, and filtration plants have been found to be very versatile and low maintenance, but do require operator involvement. Reverse osmosis and membrane systems typically work best when pre-filtered or in low turbidity waters (less than 2 NTU). More turbid waters tend to prematurely plug up and cause frequent and costly replacement of the membranes.

4.3.6 Water Conservation Technologies Overview

Water conservation technologies are quite varied. Vacuum toilet systems have been used with relative success at recreational and ski areas in the National Parks. Low flow toilets have been used successfully in remote northern sites. Retrofit devices on conventional toilets have not been overly successful in remote regions. Low flow showers especially designed for reduced consumption are preferred over flow control devices installed in-line with conventional shower heads. Grey water systems, while effective at reducing waste water flows, tend to be costly and have not had wide-spread application in Alberta. Regardless of the technology chosen, the impact on both the water treatment and the sewage treatment facilities must be jointly assessed, along with the obvious benefit of reduced water consumption.

Table 1

Summary of Major Factors Influencing the Appropriateness of Given Technologies

Raw Water Sources:		
Drilled Wells	-	requires a high quality, reliable groundwater source
Surface Streams/Infiltration Galleries	-	requires an adequate and quality stream flow close to facility
Rainwater Collection	-	generally not reliable; may be considered as a supplementary source
Fresh Water Hauling	-	low capital cost, high operational costs; most appropriate for smaller or temporary sites
Water Treatment Systems:		
Pressure Vessel Systems	-	ideal for groundwater treatment or pre-treatment of surface waters
Package Water Treatment Plants	-	reliable systems; require well trained operator
Slow Sand Filters	-	a simple, reliable, low maintenance system; not suited for intermittent operation
Reverse Osmosis/Nana Filters	-	performs best with relatively clean raw water
Water Conservation Devices:		
Retrofit Devices with Conventional Toilets	-	useful but may diminish performance of fixtures; best fixtures are those specially designed for lower consumption
Outhouse/Portable Toilets	-	low cost and portable but uncomfortable and odorous
Composting	-	utilize a simple biological process but some maintenance is required
Grey Water Recycling	-	expensive but effective if water is scarce
Ultra Low Flow Toilets	-	effective cost and water saving fixture designed for reduced water consumption
Vacuum Toilets	-	relatively complex but effective when water is very scarce; can be costly and noisy
Low Flow Shower Heads	-	cost effective and if well designed will be accepted by users; saves water and energy
In-Line Flow Controls	-	can cut water use and costs but may not work well with some conventional fixtures
Wastewater Treatment:		
Effluent Holding Tanks	-	generally low capital cost but high operational costs; best suited for small or temporary facilities
Septic Tank and Tile Fields	-	a reliable conventional technology, but requires adequate soils and space
Rotating Biological Contactors	-	portable mechanical units need nominal operator involvement
Passive Three Component Systems	-	a promising low maintenance system based on combining conventional technologies
Living Machines	-	promising biological systems, but will require a heated building and nominal maintenance

4.3.7 Wastewater Treatment Systems Overview

The choice of an appropriate wastewater treatment system can be the most crucial to the facility serviced. The emerging technologies outlined hold much promise, but further investigation and monitoring will need to be done prior to broad acceptance by the regulatory bodies. Traditional septic tanks and tile fields may be troublesome in montane areas due in large part to possible incompatible soil and groundwater conditions, as well as the capacities of such systems being insufficient. Supplementing such systems with other passive traditional technologies seems most promising. Mechanical systems such as RBC units are proven effective, but do require a higher degree of operational commitment.

4.4 Conclusions

The series of matrices outlines generic "black-box" technologies which must be applied to actual sites with a great deal of sensitivity to the actual site and the operational considerations. From discussions with contractors, suppliers, practitioners, and researchers involved in the field, there seems to be a general consensus on a number of points concerning the application of these technologies to actual sites:

- detailed feasibility assessments on a site by site basis and thoughtful consideration of the most appropriate technology can minimize later problems with the operational phase of the facility.

- there are no simple, generic solutions to the challenge of servicing remote sites with potable water and especially with sewage treatment; detailed analysis and assessment on a site by site basis is required and must include a review of water quality and quantity concerns as well as geotechnical review of the soils and groundwater table;

- discussions with the regulating bodies such as Alberta Environmental Protection are invaluable in the feasibility stage to better identify the best options;

- unproven technologies are often not favoured by the regulatory bodies; to facilitate the approval process, systems usually should have a proven track record either through local experience, extensive use in similar circumstances, or through small scale pilot studies;

- simple, basic, and passive technologies (or combinations thereof) which may require a little more capital investment but much less operation and maintenance costs should be considered first; such systems rely on gravity and slow timed release products (eg. chlorine pucks to disinfect effluent flows); they are more easily maintained than mechanical systems;

- systems which rely extensively on mechanical components can provide good service and product quality, but require highly trained operational staff as opposed to more passive systems; where larger lodging facilities are clustered in a general area, the cost effectiveness of the more sophisticated mechanical systems and their higher operational commitment can be realized by the use of common operators;

- the availability of competent, trained operations personnel capable of visiting remote sites on a regular basis must be considered;

- where natural systems (such as wetlands) exist, they should be used and integrated into the treatment process;

5.0 Waste Management

5.1 Introduction

There are a number of benefits of waste minimization which may motivate a remote lodge operator to implement a waste minimization plan. These factors include:

- Reduction of operating costs.
- Compliance with waste management related regulations.
- Reduction of risks associated with hazardous wastes.
- Protection of environmental values.
- Promotion of a positive public image.

Reduction of operating costs and the projection of a positive and credible public image are likely to be the most important relative to the success of the operation. This section offers practical options for waste reduction which will allow operators to realize these benefits.

5.1.1 Methodology

A generic list of activities at remote lodges was prepared. From this list potential significant wastes streams associated with the activities were identified. In the absence of audits of the specified operations, waste stream identification was based on the authors' experience in tourism and other relevant business sectors.

A package of alternative waste management practices appropriate to remote tourism operations and relevant to the identified waste streams was assembled. Waste minimization technologies which support these practices were entered into the summary matrix. The conclusions represent the most likely generic approach to be taken by an operator which guides waste management planning and the selection of a site specific package of options.

Specific waste management technologies and practices applied to any given operation will ultimately vary according to operating conditions such as operation feasibility, and logistics. Waste management will also be interrelated with the technologies which are selected to achieve water and energy conservation.

5.1.2 Activities And Potentially Significant Waste Streams

The following activities are expected to be significant within the operations described in the study methodology (Section 2.2).

- Office activities
- Construction
    - Facility construction
    - Landscape construction
- Transportation
    - Vehicle/aircraft operation
    - Vehicle/aircraft maintenance and repair
    - Vehicle/aircraft fueling
- Accommodation:
    - Staff and client residential activity such as sleeping, toilet, and shower
    - House keeping and laundry
- Indoor Living Activities
- Food Service:
    - Centralized dining and kitchen facilities
    - Take out food service for day trip activities
- Energy Supply Service
    - Fuel storage
    - Battery storage and maintenance
- Equipment maintenance and repair
- Water Supply Service
    - Storage
    - Equipment maintenance and repair
- Sewage Service
    - Storage
    - Processing

Potentially significant waste streams which are likely to be generated by the above activities are listed below. Sewage services, energy, and water conservation issues are discussed in Sections 3 and 4 of this report.

- Batteries - Dry Cell
- Batteries - Lead Acid
- Cleaners - Lodge, Equipment and Shop (includes solvents and personal care products)
- Construction Wastes
- Filters
- Fuels - Compressed Gas
- Fuels - Liquid Petroleum
- Fuels - Solid
- Glass
- Metals
- Oils - Machine applications
- Oils and Grease - Cooking
- Organics - Food Waste
- Paper Products
- Plastic Containers
- Tableware

Waste management options for these waste streams are individually discussed in more detail in Appendix B of this report.

The options listed in Appendix B are those which are considered viable in remote tourism lodge operations such as a lodge or lodge and cabins. However, the actual waste management options to be selected will depend on interrelationships among factors such as site design, specific technologies installed, the geographical setting of the lodge and the availability of regional waste management infrastructure.

5.2 Waste Management Strategies

Waste management at a remote tourism lodge may be guided by applying the hierarchy of the Four R's (reduce, reuse, recycle, recover) according to the specific waste management strategies described in Section 5.2.2.

5.2.1 Applying The Four R's

The four R's are important principles to consider in planning a waste management program: **reduce, reuse, recycle** and **recover**.

The order in which the four R's are implemented is important. In developing a waste management strategy, reducing is preferable to reusing, reusing is preferable to recycling, and recycling is preferable to recovering energy. The higher priority R's contribute the most to waste reduction with the least expenditure of energy and materials. For example, **reducing** wastes by not purchasing excessive packaging is simple, may reduce costs and reduces the amount of material thrown away. Similarly, **reusing** materials rather than replacing them can reduce costs and the volume of waste. **Recycling** of packaging materials, while preferable to disposal, will require a collection system and some energy input to transport materials. Waste **recovery** (eg. waste heat) generally will require capital investment in equipment for this purpose and will have associated operation and maintenance costs.

Composting is another activity which can make an important contribution to waste reduction (On site composting is effectively a form of reusing. Supplying organic materials to a centralized composting facility is similar to recycling). There may be special factors, such as wildlife concerns or climatic constraints, to consider in the use of composting at remote lodges. This is best left to specific composting manuals from which operators can chose methodologies according to site, equipment, climate, operating constraints, raw materials, etc.

The objective of applying the Four R's to remote lodge operations is to reduce the amount of potential waste materials imported to the site. For those materials imported to the site the principles of the Four R's are applied to minimize waste generation. For those wastes or residual materials which are generated the approach is to ensure that they are handled in ways which allow for efficient removal and which facilitate Four R options or efficient disposal off site.

5.2.2 Specific Waste Management Strategies

Lodge operators should be aware that the final disposal options for industrial wastes in Alberta are controlled by the Public Health Act and the Alberta Environmental Protection and Enhancement Act.

The Waste Management Regulation of the Public Health Act requires that wastes be deposited for final disposal in an approved waste management facility or landfill. Lodge operators must ensure that all wastes are disposed of in a facility with appropriate approvals for the types of waste which are sent to it. The use of unapproved disposal pits is not acceptable under the Public Health Act thus on site disposal of wastes is an unlikely option. A remote lodge is also unlikely to be able to afford incineration technology suitable for approval under the Alberta Environmental Protection and Enhancement Act. In presenting the following waste minimization options, it is assumed that final disposal of any residual wastes will take place in approved facilities off site.

.1 Purchasing

Elimination and Substitution

Elimination involves changing an operating process so that a certain material is no longer required. For example, switching to solar energy can eliminate the need for motor oils and fuels used in electrical power plants.

Purchasing managers can encourage elimination by periodically examining inventory lists for unused materials, by encouraging zero-based budgeting and by requesting justification for purchasing materials not previously used in the operation. For example, a request to purchase a new cleaning solvent should indicate which solvent this is replacing.

Substitution involves purchasing materials which result in less waste or which are less environmentally damaging than the product they are replacing. An example of this would be the replacement of strong chemical cleaners with less harmful products such as citrus based cleaners. Purchasers should be aware of new products as they are introduced to the market, and should communicate relevant information to guests.

Purchasing in Bulk

Purchasing in bulk reduces the amount of packaging to be disposed of and can result in a lower cost for materials. A simple change from one-litre to four-litre containers for fluids can result in a 50%

reduction in container waste.

Purchasing smaller containers is often used for convenience in dispensing materials at remote operating sites. However, fluids can be purchased in bulk, stored at central locations and dispensed into reusable small containers. Smaller containers which are being reused should have properly fitted lids that will not leak if the container is tipped over.

When purchasing in bulk, careful attention should be paid to the quantities required. The advantages of purchasing in bulk may be lost if excess materials must be disposed of because they have become contaminated, out-of-date or are difficult to move to another site. Shelf life is a particularly important consideration when purchasing foods in bulk.

Reducing Packaging

In addition to purchasing in bulk, waste packaging can be reduced by specifying reduced or reusable packaging in purchasing contracts. Purchase requests could specify that preference will be given to products delivered in reduced, reusable or returnable packaging. This already commonly occurs with liquids delivered in plastic pails but could be extended to other materials. Often, the materials are available in returnable containers at no additional cost. This may be a critical strategy for lodge operations wishing to avoid the large amounts of corrugated cardboard associated with delivery of foodstuffs.

Linking Purchasing and Recycling

Purchase requests could also specify that preference will be given to suppliers who will take back the used product for recycling. For materials such as plastic bulk food pails or batteries, supply contracts could indicate that the supplier of the new materials will take back the used product for recycling. Return of used materials may be coordinated with pick up or delivery of new supplies.

Purchasing Durable Goods

Purchasing higher quality, more durable equipment and parts will result in lower maintenance costs, less down time and less waste. For example, durable solar or wind energy sources can reduce the frequency of operating traditional backup diesel or gasoline fueled power plants and reduce the generation of associated waste fluids and emissions.

Purchasing Reusable Goods

Wherever it is cost effective, avoiding the purchase of disposable items should be considered. The cost analysis of reusable versus disposable goods should incorporate the cost of proper disposal which may include staff time, vehicles and tipping fees at landfill sites.

Examples include selecting reusable cups versus disposable cups in kitchens, and the use of cloth rags instead of paper towels for parts cleaning or spill cleanups. the use of reusables can assist in minimizing wastes being exported from the lodge site and so minimize the associated costs.

Purchasing Recycled Products

The purchase of products with a recycled content can stimulate both local and regional markets for recycled materials. The development of a local market may open up additional recycling options.

If reusable containers are not available, purchasers could inquire about products in containers made of recycled materials and which are recyclable. For example, food products may often be purchased in recyclable metal, glass, or plastic containers.

.2 Materials Storage And Handling

Adequate Material Storage

Waste can often be prevented by careful storage and handling of materials. Materials stored outside and unprotected from the elements may become damaged, contaminated or unusable. For example, scraps of wood or metal can be damaged by weather so that they cannot be used in future projects or will fetch less value from a recycler.

Materials stored randomly on lodge grounds are subject to damage or may be simply lost or forgotten. Well organized storage areas, with well marked shelving and inventory control levels, can reduce the amount of lost, damaged and out-of-date product that requires disposal, while reducing the unnecessary purchase of new materials.

Spill Prevention

Should leaks and spills occur, not only are valuable materials lost, but large quantities of contaminated soil or water may have to be treated or disposed of as well. Importing topsoils or other materials to reclaim spill sites may be very expensive for remote lodge operations.

Simple maintenance and correction of leaking valves, pipes, nozzles and tanks can prevent losses of liquid materials used in the lodge operation. The use of flow controls, overflow level controls and larger capacity tanks also helps prevent losses.

The use of adequate pumps, funnels and well maintained hoses and nozzles can reduce losses during the transfer of materials. The filling of tanks and containers should be carefully monitored to prevent overflows. Berming storage tanks for fuels can limit the extent of contamination if accidental spills do occur.

.3 Equipment Maintenance And Operation

Preventative Maintenance and Quality Control

Preventative maintenance and quality control programs can reduce wastes and costs including the cost of using and disposing of duplicate materials for a job not done correctly the first time. Preventative maintenance can extend equipment life and prevent accidental losses of materials.

Setting and implementing careful equipment operating procedures will reduce maintenance costs, save materials and reduce wastes. For example, careful use of vehicles can save fuel, reduce tire wear and avoid wasted parts due to unnecessary breakdown.

Minimizing Use Of Materials

Waste can often be reduced by using the minimum amount of material required. This reduces material purchase and waste disposal. For example, organic food wastes can be significant wastes generated by food service activities. By preparing only the amounts of food which are likely to be consumed, and minimizing the amount of greases and oils used in food preparation, significant waste reduction may be achieved. Mixing cleaners and solvents to specified strengths can conserve materials and avoid potential disposal problems.

.4 Waste Storage And Handling

Source Separation of Wastes

Potentially recyclable and reusable materials such as paper, plastic or metal containers, and compostable food wastes are often `contaminated' by being mixed together in collection pails or bins. The separation of wastes at their source is the key to successful recycling and reuse opportunities in business. Waste materials destined for recycling or reuse require the same care in storage and handling as new materials. These materials can be viewed as resources rather than wastes, and their value can be increased through appropriate storage and handling and by avoiding contamination.

The number of separations required will depend on the market for the materials. Such details should be worked out with the recyclers in advance and an appropriate separation system designed. The number and placement of containers should make it easy both for the employee to recycle the material and for disposal of the material.

The mixing of hazardous with non-hazardous wastes may result in an entire bin of wastes requiring disposal as hazardous waste at great expense thus it is important to separate hazardous from non-hazardous wastes.

Waste Transportation

A common barrier to waste minimization in remote operations is the isolated location. This creates difficulties in transporting waste materials to approved disposal sites and in moving materials to central locations for reuse or recycling. This problem can be addressed by implementing a "carry in - carry out" policy. All materials used in a lodge operation have to be transported. The same means of transportation can be used to carry wastes out of the operation. The "carry in - carry out" policy can often move wastes at little or no extra cost to the operation.

Operators may ensure that these "carry in - carry out" options are available to and applied by all of their contractors especially during any construction and servicing activities.

Cooperative Waste Systems

In many small lodge operations it is likely that the small quantities of wastes or recyclables make it difficult to justify additional waste disposal or recycling systems, so individual operators, therefore, may be reluctant to implement such systems. However, opportunities may exist for cooperative waste minimization systems. For example, the cost of moving small quantities of corrugated cardboard to a recycler may be prohibitive for a single company. However, a number of business operators in the same area, or which base their supply activities from the same community, could consider working together with the municipality or community recycling program to develop a cooperative recycling program.

Client Education

The success of waste minimization in service industries often depends on customer expectations and understanding of the advantages of waste minimization. The reasons for an operation's waste minimization plan could be explained in lodge literature. Practices such as cooking to minimize the need for cleaning grease and oils or requesting that guests bring in and carry out their own soaps and shampoos could be identified in advance. It is likely that, with advance information, guests will consider this part of the remote experience and be pleased to contribute to the lodge's environmental policies.

5.3 Technologies And Practices

The matrix in Table 3 of Appendix A summarizes applicable waste management technologies. Appendix B lists, in much greater detail, a range of possible waste minimization options for operators of remote lodges. Many of the options included have been presented in previous waste minimization manuals (Alberta Environment 1992, Alberta Environmental Protection 1993, Alberta Environmental Protection 1994, Canadian Restaurant and Foodservices Association 1992, Robinson and Duck 1994, Troyer 1992) and have been edited to suit the remote lodge scenarios.

Some technologies and practices which require significant processing on site are not considered here due to the potential demand for energy and costly equipment, and for secondary pollutants arising from processing. For example, incineration is not considered due to high energy demands and the high cost of incineration equipment to meet current approved standards.

5.4 Conclusions

The major cost of waste management for remote lodges is likely to be the cost of transportation to and from the site. Disposal of solid wastes on site through landfill or incineration in order to reduce the need to transport wastes is either not acceptable to regulatory authorities, or approved technologies are likely to be too expensive. Waste residuals and recyclables will, therefore, need to be exported from the site. Thus, the waste management planning priorities for remote lodges are:

- Reduce materials imported to the site
- Reduce the amount of material generated on site
- Maintain the quality of used and residual materials

- Reduce the weight and volume of materials which must be transported off the site

The following basic principles can guide the development of operation specific waste minimization plans which address these priorities for remote tourism lodges.

- Guests could be informed of the facility's waste minimization plan. The information provided could illustrate the benefits of waste minimization, the waste minimization plan, and the manner in which guests may contribute to the plan.

- Practices which reduce the amount of materials imported to the site generally support waste management practices.

- Planning for movement of people and goods to and from the site should include allowance for the regular transport of wastes from the site to minimize the need for special waste handling trips or guest/garbage encounters.

- Lodge design should incorporate adequate space for waste management activities such as material segregation and storage.

- Any off-site base of operations should also be considered in waste minimization practices.

- Lodge operators should keep in touch with local communities to keep current with waste minimization initiatives such as reuse and recycling opportunities.

- Lodge operators should improve waste minimization relationships with their suppliers.

6.0 Life Cycle Costing

6.1 Why Life Cycle Costing?

It is useful to compare the life cycle costs of potential scenarios so that the potential user can see what the actual costs are over the lifetime of each scenario. In this manner a true comparison on an equal basis can be made. Life cycle costs take into account interest rates (assuming that money is borrowed for the facility), return on investment (what rate could the user expect to receive merely by investing his money) and inflation rates (the value of the money decreases in time so the real costs need to be determined).

The technique of life cycle costing breaks out the cost of installing, operating and replacing each component of the facility and also takes account of the time value of money. It can, therefore, be used to compare one energy, water, sewer and waste system with another, or to compare alternatives to conventional methods. This will help the planner choose the most cost-effective integrated system for a given facility. As well this methodology can be used to compare individual alternatives (such as one sewage system to another) or the relative costs of changing or not changing an existing system (such as converting an existing diesel generation system to a battery cycle charging system).

For a new system, the Life Cycle Cost of the system is the sum of the following costs:

Life Cycle = Capital + Maintenance + Energy + Replacement - Salvage

Capital cost of the system includes design, engineering, capital equipment, and installation costs. The capital cost can be a lump sum or a series of principal and interest payments over the life of the system.

Maintenance cost for the system, is the sum of all yearly scheduled maintenance and operating costs, including operators fees, inspections, insurance, taxes, small part replacement, etc.

Energy cost for the system, is the sum of all yearly purchases of fuel used by the system. This will obviously be zero for non-fueled energy systems. This cost will vary according to the energy consumption determined for the facility.

Replacement Cost is the cost of replacing components over the life of the system. This is normally the sum of lump sums paid for replacement of components whose life span is less than that of the life cycle being analyzed.

Salvage Value is the net value of the system at the end of its useful life. It, of course, is a "negative cost".

Because the above costs will occur in different years, it is necessary to convert these future costs into present-day equivalents or "present worth". This is done using an assumed "discount rate" which is a measure of the rate of return expected by an investor, adjusted for inflation. For example, if an investor expects a 10% per annum rate of return on his money, and the average annual inflation rate over the life of the system is expected to be 4%, a discount rate of 6% per annum should be used.

6.2 Method

The following method described assumes that a new facility is being planned and therefore all of the costs of the various components and alternatives need to be considered. The method can also be employed for simpler technology/practice comparisons or to compare existing to renovated facilities. In these cases adjust the input of costs and the treatment of them to most closely reflect the case being examined. For example, in the case of an examination of a new system to a system that has been paid for, there would be no capital costs for the existing system, but there may be replacement costs at an earlier future date.

If the entire integrated system is being examined, there are numerous combinations and alternatives that can be examined. The decision making process as a result will be iterative. To facilitate this it may make sense to use a computer spreadsheet to allow easy and rapid changes to the inputs. In this way an unlimited number of scenarios can be examined in a reasonable length of time.

The first step in this analysis is to select the various alternatives to be examined and to determine their capital and O&M costs. At the same time the energy consumption of the entire facility (employing the technologies or practices chosen) should be determined. Following is an example of a work sheet that could be employed in determining electric energy needs. This work sheet should be completed for the average and the highest load scenario (usually coldest weather and shortest day).

Table 2

Electric Energy Worksheet

Load	Voltage	Amperage	kVA (watts)	Hrs per day	kWh/day
lights					
dishwasher					
etc.					
TOTAL					

Fuel needs can be determined in the same manner.

Electrical loads or fuel needs for heating will, of course, depend on the design of the facility and the technologies employed - these can be most accurately estimated by a qualified engineer.

Once electrical loads have been determined,

Table 3

Fuel Needs Worksheet

Source	Electrical generation (kWh)	consumption /kWh	Heating requirement (kJ)	consumption /kJ	Other consumption
generator 1					
generator 2					
furnace					
hot water					
etc.					
TOTALS					

a generation system to meet the loads can be selected and the consequent fuel needs (if any) of that system can be estimated.

In summary, the information that needs to be collected for the energy, water, sewer and waste system for the facility is:

- capital costs for all components of the system
- maintenance costs for all components of the system
- annual energy needs of the facility
- fuel consumption of the facility
- fuel costs based on this consumption (transportation costs should be included)
- life span of the various components of the system

The other parameters in the life cycle cost must also be determined. System life is of obvious importance. Typically, 20 years is utilized, however this analysis can be performed for any length of time. Shorter periods may not truly reflect the cost benefit of long life components of the system. The assumptions made about inflation and investment costs have the potential to distort the costs for longer periods. The amortization period of loans or mortgages for the facility is generally the most useful time frame to utilize.

The loan interest rate should be that which is currently available for the amortization period chosen. The investment rate should be that which is again available for investments comparable to the capital cost and duration of the loan or mortgage. The inflation rate used is typically 4 - 5% for a 20 year life cycle. It should be remembered that this is an average rate over this period and is based on historical trends. For shorter life cycle periods it may be advisable to use a rate which more closely reflects the current trend. A separate inflation rate for fuel is suggested as historically fuel costs have increased more rapidly than general inflation. This is expected to continue as environmental costs are added to fuel costs.

The following simple example illustrates the use of life cycle costing* . The comparison is between a small photovoltaic (PV) system and a gasoline generator. The PV system is sized to provide the power required with battery storage to provide power during low or no sun periods and to provide short term peak power of up to 5 kW when needed. The gasoline generator is sized to provide the same peak power.

---

* from *Photovoltaic Systems Design Manual*, Canadian Photovoltaics Industries Association for Energy, Mines and Resources Canada, 1991.

Table 4

Life Cycle Cost Example

Economic Parameters

System life = 20 years
Loan interest rate = 10%
Investment rate = 10%
Inflation rate = 5%
Fuel inflation rate = 8%
Net discount rate = 5% (investment rate - inflation rate)
Net fuel discount rate = 2% (investment rate - fuel inflation rate)

Basic costs[1]:

	Photovoltaic System	Generator System
Capital costs	$12,000	$8,000
Salvage (20%)	($2,400)	($1,600)
Annual maintenance cost	$50	$300
Annual fuel cost	$0	$200
Battery replacement cost	$1,000	
Engine rebuild cost		$500

Present Worth[2]:

	Photovoltaic System	Generator System
Capital (20 yearly payments)[3]	$17,319	$11,538
Maintenance costs[4]	$620	$3,738
Fuel costs[5]		$3,270
Replacement/rebuild costs[6]		
• battery replacement at 10 years	$610	
• engine rebuild every 5 years		$940
Salvage value[7]	($900)	($600)
Total life cycle cost	**$17,469**	**$18,886**

Notes:

1. Costs in current dollars of individual components of system
2. Present value of individual costs over life of the two systems
3. 20 annual payments of principal and 10% interest at a net discount rate of 5%
4. 20 annual payments for maintenance at a net discount rate of 5% (Uniform PWF)
5. 20 annual payments for fuel at a net discount rate of 2% (Uniform PWF)
6. Single payment for replacements/rebuilds at a net discount rate of 5% (Single PWF)
7. Single receipt for salvage at end of 20 years at net discount rate of 5% (Single PWF)

To convert future costs to their present worth, multiply them by the Present Worth Factor, a factor based on an assumed discount rate and number of years. Two types of Present Worth Factor (PWF) can be used - A Single PWF to convert a single payment in a particular year such as replacement (or salvage value), and a Uniform PWF to convert a recurring annual cost from the present to the particular year. Single and Uniform PWFs are given in the following tables for discount rates up to 12% and periods up to 25 years. A table of yearly principal and interest at different rates is also given.

6.3 Cautions

In performing this analysis it is critical that all technologies and options are treated in the same manner and that all costs are included for each (such as rebuilds, overhauls, replacements). Otherwise the results will not reflect the true life cycle costs. When different scenarios are examined, it is important to ensure that all inter-relationships are accounted for. For example, a technology may be chosen to replace another one because it is more energy efficient, but it may increase transportation needs, and these costs need to be accounted for.

It is important to remember that life cycle costs do not account for non-monetized parameters that may be important such as environmental and social externalities. Environmental benefits will not actually have a cost savings to them but may be important to the operator of a facility or to development authorities and may over ride extra costs. Similarly, if the use of certain technologies makes economic sense but means that the facility is unable, for example, to obtain a permit, then obviously life cycle costs are irrelevant in this instance. As the facilities are tourism based, it is also important to consider effects on occupancy rates (which are not included in the analysis). If different technologies or practices have the potential to affect occupancy or use then this may have to be considered over and above the life cycle costs.

In summary, life cycle costing analysis can be used to assist the decision making process but should not be used as the sole decision maker.

6.4 Conclusions

- life cycle costing should be considered by operators for comparing the various alternatives on a true cost basis
- accurate and detailed information is important to a proper analysis

- other considerations than direct costs should be considered in addition to life cycle costing
- computer based spreadsheet analysis can aid in this analysis and allow a more extensive look at the various options

Table 5

Single Present Worth Factors

Net discount rate

Year	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	0.391	0.361
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350	0.317	0.287
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319	0.286	0.257
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290	0.258	0.229
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263	0.232	0.205
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239	0.209	0.183
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218	0.188	0.163
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198	0.170	0.146
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180	0.153	0.130
19	0.828	0.686	0.570	0.475	0.396	0.331	0.277	0.232	0.194	0.164	0.138	0.116
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149	0.124	0.104
21	0.811	0.660	0.538	0.439	0.359	0.294	0.242	0.199	0.164	0.135	0.112	0.093
22	0.803	0.647	0.522	0.422	0.342	0.278	0.226	0.184	0.150	0.123	0.101	0.083
23	0.795	0.634	0.507	0.406	0.326	0.262	0.211	0.170	0.138	0.112	0.091	0.074
24	0.788	0.622	0.492	0.390	0.310	0.247	0.197	0.158	0.126	0.102	0.082	0.066
25	0.780	0.610	0.478	0.375	0.295	0.233	0.184	0.146	0.116	0.092	0.074	0.059

Table 6

Uniform Present Worth Factors

Net discount rate

Year	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	.0917	0.909	.0901	0.893
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605
6	5.795	5.601	5.417	5.242	5.076	4.917	4.767	4.623	4.486	4.355	4.231	4.111
7	6.728	6.472	6.230	9.002	5.786	5.582	5.389	5.206	5.033	4.868	4.712	4.564
8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.146	4.968
9	8.56	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.537	5.328
10	9.471	8.983	8.530	5.111	7.722	7.360	7.024	6.710	6.418	6.145	5.889	5.650
11	10.368	9.787	8.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	6.207	5.938
12	11.255	10.575	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	6.492	6.194
13	12.134	11.348	10.635	9.986	9.394	8.853	8.358	7.904	7.487	7.103	6.750	6.424
14	13.004	12.106	11.296	10.563	9.899	9.295	8.745	8.244	7.786	7.367	6.982	6.628
15	13.865	12.849	11.938	11.118	10.380	9.712	9.108	8.559	8.061	7.606	7.191	6.811
16	14.718	13.578	12.561	11.652	10.838	10.106	9.447	8.851	8.313	7.824	7.379	6.974
17	15.562	14.292	13.166	12.166	11.274	10.477	9.763	9.122	8.544	8.022	7.549	7.120
18	16.398	14.992	13.754	12.659	11.690	10.828	10.059	9.372	8.756	8.201	7.702	7.250
19	17.226	15.678	14.324	13.134	12.085	11.158	10.336	/.604	8.950	8.365	7.839	7.366
20	18.046	16.351	14.877	13.590	12.462	11.470	10.594	9.818	9.129	8.514	7.963	7.469
21	18.857	17.011	15.415	14.029	12.821	11.764	10.836	10.017	9.292	8.649	8.075	7.562
22	19.660	17.658	15.937	14.451	13.163	12.042	11.061	10.201	9.442	8.772	8.176	7.645
23	20.456	18.292	16.444	14.857	13.489	12.303	11.272	10.371	9.580	8.883	8.266	7.718
24	21.243	18.914	16.936	15.247	13.799	12.550	11.469	10.529	9.707	8.985	8.348	7.784
25	22.023	19.523	17.413	15.622	14.094	12.783	11.654	10.675	9.823	9.077	8.422	7.843

Table 7

Yearly Principal and Interest Payments per $1000 Loan

Term

Loan rate	5 year	10 year	15 year	20 year	25 year
0.0800	$250.46	$149.03	$116.83	$101.85	$93.68
0.0825	$252.11	$150.71	$118.62	$103.75	$95.69
0.0850	$253.77	$152.41	$120.42	$105.67	$97.71
0.0875	$255.43	$154.11	$122.23	$107.60	$99.75
0.0900	$257.09	$155.82	$124.06	$109.55	$101.81
0.0925	$258.76	$157.54	$125.90	$111.50	$103.88
0.0950	$260.44	$159.27	$127.74	$113.48	$105.96
0.0975	$262.11	$161.00	$129.60	$115.46	$108.06
0.1000	$263.80	$162.75	$131.47	$117.46	$110.17
0.1025	$265.48	$164.50	$133.36	$119.47	$112.29
0.1050	$267.18	$166.26	$135.25	$121.49	$114.43
0.1075	$268.87	$168.03	$137.15	$123.53	$116.58
0.1100	$270.57	$169.80	$139.07	$125.58	$118.74
0.1125	$272.27	$171.59	$140.99	$127.63	$120.91
0.1150	$273.98	$173.38	$142.92	$129.70	$123.10
0.1175	$275.69	$175.18	$144.87	$131.79	$125.29
0.1200	$277.41	$176.98	$146.82	$133.88	$127.50
0.1225	$279.13	$178.80	$148.79	$135.98	$129.72
0.1250	$280.85	$180.62	$150.76	$138.10	$131.94
0.1275	$282.58	$182.45	$152.75	$140.22	$134.18
0.1300	$284.31	$184.29	$154.74	$142.35	$136.43
0.1325	$286.05	$186.13	$156.74	$144.50	$138.68
0.1350	$287.79	$187.99	$158.76	$146.65	$140.95
0.1375	$289.54	$189.85	$160.78	$148.81	$143.22
0.1400	$291.28	$191.71	$162.81	$150.99	$145.50
0.1425	$293.04	$193.59	$164.85	$153.17	$147.79
0.1450	$294.79	$195.47	$166.90	$155.36	$150.08
0.1475	$296.55	$197.36	$168.95	$157.55	$152.39
0.1500	$298.32	$199.25	$171.02	$159.76	$154.70
0.1525	$300.08	$201.15	$173.09	$161.98	$157.02
0.1550	$301.85	$203.06	$175.17	$164.20	$159.34
0.1575	$303.63	$204.98	$177.26	$166.43	$161.67
0.1600	$305.41	$206.90	$179.36	$168.67	$164.01

7.0 Conclusions

The following are general conclusions resulting from the study. Conclusions about specific technologies are made at the end of Sections 3, 4, 5 and 6.

7.1 General

- operators of existing facilities should be encouraged to undertake an environmental audit of their operation.

- it is important that relevant existing and new information produced by government, such as Alberta Environmental Protection's Action on Waste Program, is well circulated and accessible to current and potential lodge operators.

- any actual implementation of a retrofit or a new facility based on the examples indicated in this study (whether initiated by private sector, academia, or government) would provide valuable information to all parties, by demonstrating the decision making process and the real life practicalities of implementing alternative technologies.

- developers and operators should be encouraged to look at low impact alternatives as part of their business or development plans, and consider implementing those which are demonstrated to be feasible.

7.2 Energy Sources and Systems

- the constraints of the study budget were such that alternatives in 'conventional' fossil fuel based generation were not examined. However, there are various alternatives which may reduce impact, relating to fuel type, sizing, controls, multiple unit synchronization, etc. Further examination of these alternatives would be beneficial.

- developers and operators would find it beneficial to assess site specific renewable energy resources to determine the potential and feasibility for use.

- the establishment of permit and inspection requirements for remote facilities utilizing alternative energy systems, combined with education of the inspecting authorities as to the current state of the technology, would expedite facility planning and development. For example, at present there are no clear codes and/or accepted practices for solar (PV) installations, and many inspectors have never dealt with DC power systems or the specialized components which are not common to conventional systems.

7.3 Water and Sewage Management

- the implementation of small scale projects using some of the emerging technologies discussed in this study would be a very effective way to provide evaluation information for regulatory bodies and developers of remote facilities

7.3 Waste Management

- documented examples of lodge operators who have implemented successful waste minimization alternatives would assist other operators who may consult them for advice.

- the development and implementation of waste management plans would be beneficial to build into new lodge developments, as well as existing lodges.

7.5 Life Cycle Costing

- the development of a generic life cycle costing model, with spreadsheets, that can be easily used by remote facility operators in their planning and decision making process would be extremely helpful.

8.0 References

Alberta Environment, 1980: **Design and Construction of Liners for Municipal Wastewater Stabilization Ponds,** Alberta Environment, Standards and Approvals Division, Municipal Engineering Branch, Edmonton.

Alberta Environment, 1992: **Waste minimization manual: construction and demolition industry**, Alberta Environment, Edmonton.

Alberta Environmental Protection, 1993: **Waste minimization manual: vehicle maintenance and repair industry**, Alberta Environmental Protection, Waste Minimization Branch, Edmonton.

Alberta Environmental Protection, 1994: **Waste minimization manual: landscape services industry**, Alberta Environmental Protection, Waste Minimization Branch, Edmonton (in press).

Cameron, J. and B.C. Armstrong, 1994, "Water and Energy Conservation Alternatives for the North", as appended to **Water Efficiency Strategy for the Northwest Territories: Background Paper**, Department of Municipal and Community Affairs, Government of the Northwest Territories, Yellowknife, N.W.T.

Canadian Photovoltaics Industries Association, 1991: **Photovoltaic Systems Design Manual**, Energy, Mines and Resources Canada, Ottawa.

Canadian Restaurant and Foodservices Association, 1992: **Going green without seeing red: An environmental guide for the food services industry**, CRFA, Toronto.

Department of Municipal and Community Affairs, 1994, **Water Efficiency Strategy for the Northwest Territories: Background Paper**, Department of Municipal and Community Affairs, Government of the Northwest Territories; Yellowknife, N.W.T.

Robinson B.K. and P.J. Duck, 1994: **Waste minimization manual for Alberta forestry operations**, Willow Root Environmental Limited, Banff.

Tate, D.M., 1990, **Water Demand Management in Canada: A State-of-the-Art Review**, Social Sciences Series No. 23, Inland Waters Directorate, Water Planning and Management Branch, Environment Canada, Ottawa, 1990.

Troyer, W., 1992: **The green partnership guide: 12 steps to help create an environmentally friendly setting for our guests, ourselves and our future**, Canadian Pacific Hotels and Resorts.

9.0 List of Appendices

Appendix A Technology Summaries
  Table 1 Energy Sources and Systems Matrix
  Table 2 Water and Sewer Management Technologies Matrix
  Table 3 Waste Management Matrix

Appendix B Waste Management Options

APPENDIX A

TECHNOLOGY SUMMARIES

Table 1 Energy Sources and Systems Matrix
Table 2 Water and Sewer Management Technologies Matrix
Table 3 Waste Management Matrix

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Sources											
Energy Sources - Wind Energy											
wind electric generation	• site specific • may be feasible if average wind speed >4.5 m/s • higher average wind speeds increase feasibility • obstacles to wind will reduce feasibility	• wind regime may be seasonal, otherwise appropriate year round		• no foreseeable incompatibilities • sizing and feasibility will depend on total electrical loads which may be dictated by other technologies	• no Cdn manufacturers but numerous manufacturers worldwide • several Alberta dealers and service companies	• good	• 10 kW and smaller very simple • complexity increase with size	• generally yes, may need to check with local authority, CSA, Alberta EPB, Transport Canada	• none	• no fuel costs • reduces energy requirements from other sources	• most units designed for at least 20 years
wind powered pumping	• site specific • requires sufficient wind • may require water storage for calm periods	• wind regime may be seasonal, otherwise appropriate year round	• wind regime may be seasonal, otherwise appropriate year round • freezing may pose a problem in winter	• will reduce energy requirements from other sources • could be used in water and sewage systems	• manufacturers, suppliers and service companies in Alberta	• varies between manufacturers and with cost	• simple	• generally yes, may need to check with local authorities	• none	• reduces energy requirements from other sources	• 10 - 20 years
wind powered aeration	• site specific • requires sufficient wind • if continuous aeration required- not feasible due to calm periods	• wind regime may be seasonal, otherwise appropriate year round	• freezing may pose a problem in winter, but aeration can also be used to prevent ice formation	• will reduce energy requirements from other sources • could be used in water and sewage systems	• manufacturers, suppliers and service companies in Alberta	• varies between manufacturers and with cost	• simple	• generally yes, may need to check with local authorities	• none	• reduces energy requirements from other sources	• 10 - 20 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Sources											
Energy Sources - Wind Energy											
wind electric generation	• does produce noise but typically less than the wind itself • highly visible - may or may not fit in with facility and landscape • use of 'environmentally friendly' energy may out weigh other aesthetic considerations	• should be located away from high traffic/use areas	• no affects on wildlife • terrain/ vegetation disturbance for foundations, etc.	• can eliminate air emissions from fueled generation sources	• fuel savings • low O&M costs	• prevents emissions from fueled sources	• initial capital costs	• possible noise • visibility	• $4000 to $8000/ kW	• 1-2¢/kWh	• site and resource specific
wind powered pumping	• 'farmstead' like appearance will generally fit in with remote facilities • noise is less than that of wind	• lower speeds than electric wind turbines therefore less of a hazard in event of failure • should still be located away from high traffic/use areas	• no effect on wildlife • terrain and vegetation disturbance by tower	• can reduce air emissions from fueled generation sources	• reduced energy costs	• reduced impacts from generation sources	• initial capital costs	• O&M required	• range $700-$50,000 depending on volume required and wind regime	• $100-$2000/yr	• site specific
wind powered aeration	• 'farmstead' like appearance will generally fit in with remote facilities • noise is less than that of wind	• lower speeds and usually smaller than electric wind turbines therefore less of a hazard in event of failure • should still be located away from high traffic/use areas	• no effect on wildlife • terrain and vegetation disturbance by tower	• can reduce air emissions from fueled generation sources	• reduced energy costs	• reduced impacts from generation sources	• initial capital costs	• O&M required	• range $700-$2000 depending on aeration required and wind regime	• $100-$500/yr	• site specific

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Sources - Solar Energy											
Solar electric generation (PV)	• due to high capital costs usually economically feasible only for low power needs • shading by trees, surrounding terrain and building will also affect feasibility	• longer peak sunlight hours (3-4 times those in winter) increase potential for use	• short days and lower altitude of sun (more shading potential) decrease energy availability	• no conflict with other technologies however any increases or decreases in electrical loads due to other technologies will impact costs significantly	• numerous manufacturers in Canada and worldwide • numerous suppliers and service companies in Alberta	• solar panels extremely reliable • reliability of balance of system depends on quality used but generally very good	• small systems very simple • as system size increases so does complexity of balance of system	• generally yes but for systems over 1 kW need to check with local authority, Alberta EPB and CSA (this may change in future, ie. new PV codes are being developed)	• none	• any energy provided by this technology will displace need for fuel/energy required by other sources	• at least 20 years
Solar (PV) water pumping	• feasible for moderate water needs • shading by trees, surrounding terrain and building will affect feasibility	• longer peak sunlight hours (3-4 times those in winter) increase potential for use	• short days and lower altitude of sun (more shading potential) decrease energy availability • may be freezing problems in winter	• no conflict with other technologies however limited capacity of system may have impact on water and sewer systems	• several system manufacturers in Alberta • numerous suppliers and service companies in Alberta	• solar panels extremely reliable • reliability of balance of system depends on quality used but generally very good	• systems generally quite simple	• generally yes but for systems over 1 kW need to check with local authority, Alberta EPB and CSA (this may change in future, ie. new PV codes are being developed)	• none	• will reduce energy needs required from other systems	• at least 20 years
Solar powered (PV) aeration	• feasible for small scale aeration needs • shading by trees, surrounding terrain and building will affect feasibility	• longer peak sunlight hours (3-4 times those in winter) increase potential for use	• short days and lower altitude of sun (more shading potential) decrease energy availability • may be freezing problems in winter	• no conflict with other technologies • may reduce energy requirements of water and sewer systems	• several system manufacturers in Alberta • numerous suppliers and service companies in Alberta	• solar panels extremely reliable • reliability of balance of system depends on quality used but generally very good	• systems generally quite simple	• generally yes but for systems over 1 kW need to check with local authority, Alberta EPB and CSA (this may change in future, ie. new PV codes are being developed)	• none	• will reduce energy needs required from other systems	• at least 20 years
Solar water heating (refer to solar passive design for space heating)	• needs energy for pumping • maintenance varies with quality • feasible as pre-heating system	• longer peak sunlight hours (3-4 times those in winter) increase potential for use	• short days and lower altitude of sun (more shading potential) decrease energy availability • may be freezing problems in winter	• compatible with any other water heating system • uses tank upstream of conventional • may reduce energy requirements of water and sewer systems	• several suppliers and service companies in Alberta	• components have high reliability generally • installation sensitive	• systems generally quite simple	local building inspectors may have specific concerns	• none	• will reduce energy needs required from other systems	• 10 - 20 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Sources - Solar Energy											
Solar electric generation (PV)	• small systems are unobtrusive, but as system sizes increase panel area increases (approx. $1m^2$/150 watts capacity) • no noise (no moving components)	• no unusual safety considerations other than those of electricity (DC in particular) • in order to increase feasibility electrical loads may be decreased, this may in turn affect comfort level	• no impacts other than space occupied	• can eliminate air emissions from fueled generation sources	• no fuel costs • reduced O&M costs	• no impacts associated with other energy/fuel sources	• very high initial capital costs	• may require drastic reduction in loads to make system economically viable	• $5-$6/watt	0.1¢-0.5¢/kWh	• site specific
Solar (PV) pumping	• small systems are unobtrusive, but as system sizes increase panel area increases (approx. $1m^2$/150 watts capacity) • no noise (no moving components)	• no unusual safety considerations other than those of electricity (DC in particular) • in order to increase feasibility electrical loads may be decreased, this may in turn affect comfort level	• no impacts other than space occupied	• can reduce air emissions from fueled generation sources	• reduced energy costs from other sources	• reduced impacts associated with other energy/fuel sources	• initial capital costs	• may require reduction in water requirements to make system economically viable	• $2000 - $20,000 depending on water needs and pumping requirements	0.1¢-0.5¢/kWh	• site specific
Solar powered (PV) aeration	• small systems are unobtrusive, but as system sizes increase panel area increases (approx. $1m^2$/150 watts capacity) • no noise (no moving components)	• no unusual safety considerations other than those of electricity (DC in particular) • in order to increase feasibility electrical loads may be decreased, this may in turn affect comfort level	• no impacts other than space occupied	• can reduce air emissions from fueled generation sources	• reduced energy costs from other sources	• reduced impacts associated with other energy/fuel sources	• initial capital costs	• may require reduction in aeration requirements to make system economically viable	• $2000 - $20,000 depending on aeration needs	0.1¢-0.5¢/kWh	• site specific
Solar water heating (refer to solar passive design for space heating)	• small systems are unobtrusive, but as system sizes increase panel area increases • no noise (no moving components)	• none	• no impacts other than space occupied	• can reduce air emissions from fueled generation sources	• reduced energy costs from other sources	• reduced impacts associated with other energy/fuel sources	• initial capital costs	• uses energy to circulate water	• $1500 - $10,000 depending on needs	0.1¢-0.5¢/kWh (3400 BTU's)	• site specific

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Sources - Hydro Energy											
Hydro electric generation	• feasible if sufficient head and flow are available for the energy requirements and environmental impacts are acceptable	• seasonal changes in flow may affect available energy	• seasonal changes in flow may affect available energy • may be problems with ice and freezing to be dealt with	• no foreseeable conflicts • available energy from resource may restrict energy demands by other technologies	• numerous manufacturers in Canada and worldwide • several suppliers and service companies in Alberta and BC	• highly reliable	• generally smaller systems are simpler, however water source characteristics and location relative to point of use can affect system complexity	• generally yes but permits may be needed for water use and environmental review • also need to check with Alberta EPB	• none	• fuel or energy that would have been required from another source	• 10 to 50 years
Energy Sources - Storage											
Battery cycle charging	• feasible	• no seasonal effect	• no seasonal effect	• no foreseeable conflicts • reduction in electrical loads increases cost effectiveness of this technology • battery handling and disposal will need to be considered in waste management strategy • generally very compatible	• several suppliers and service companies in Alberta	• reliable	• more complex than stand alone fueled generation source • electronic components required	• generally yes but should be checked with local authorities, Alberta EPB, and CSA	• fuel will still be required but will be reduced by the amount dictated by the system design	• fuel savings of up to and exceeding 70% are possible	• batteries will need replacement every ten years • other components will have 10 - 20+ year life
Energy Sources - Hybrid Systems											
Hybrid generation systems (combination of one or more of fueled source, wind, solar, hydro, cycle charging)	• feasibility will depend on availability of resources and energy demands	• possible seasonal variation in resource availability	• possible seasonal variation in resource availability	• sizing and feasibility will depend on total electrical loads which could be affected by other technologies • generally very compatible	• several suppliers and service companies in Alberta	• generally good, but depends on quality of components used	• combination of several technologies increases complexity, however systems are generally designed not to be overly complex • use of electronic controllers also reduces overall complexity	• generally yes but should be checked with local authorities, Alberta EPB, and CSA	• fuel may still be required but will be reduced by the amount dictated by the system design	• fuel savings of up to 100% are possible	• batteries, if used, will need replacement every ten years • other components will have 10 - 20 year life

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Sources - Hydro Energy											
Hydro electric generation	• potential visual impact could include exposed penstock, and intake structure, however in many instances these can be minimized • turbine itself does make noise but this is only audible in the immediate vicinity of the turbine and is typically mitigated by a building	• no foreseeable impacts on human safety or comfort	• potential impacts on fish depending on design and location of intake structure and amount of water removed • potential impacts on terrain and vegetation due to installation of penstock, powerhouse and electrical lines • the above impacts may or may not be significant and can frequently be minimized or mitigated	• can eliminate air emissions from fueled generation sources	• no fuel costs, low O&M costs	• prevents emissions from fueled sources	• initial capital costs	• may be some other environmental impacts	$4000 - $5000/kW	0.1 - 0.5 ¢/kWh	• site specific
Energy Sources - Storage											
Battery cycle charging	• noise from fueled generation source reduced	• batteries are classified as hazardous, however proper precautions can virtually eliminate this risk	• not relevant except in the case of a spill during transport	• batteries are classified as a hazardous waste - proper disposal and recycling eliminates any consequences • reduces air emissions from fueled source	• reduction in fuel costs • reduction in O&M costs • rapid payback	• reduction in air and noise emissions from fueled generation source	• initial capital cost	• battery disposal requirements, increased complexity	• $2000/peak kW	• minimal for system itself • reduction in fueled generation source O&M costs due to reduced operating time	• site and system specific • generally 2 - 5 years
Energy Sources - Hybrid Systems											
Hybrid generation systems (combination of one or more of fueled source, wind, solar, hydro, cycle charging)	• may reduce or eliminate noise from fueled generation source • aesthetic impacts will depend on technologies employed - refer to comments above for specific technologies	• safety and comfort effects will depend on technologies employed - refer to comments above for specific technologies	• biophysical impacts will depend on technologies employed - refer to comments above for specific technologies	• other impacts will depend on technologies employed - refer to comments above for specific technologies	• reduced or eliminated fuel costs • lowered or eliminated O&M costs for fueled generation source	• reduction in air and noise emissions from fueled generation source	• initial capital cost	• will depend on technologies employed - refer to above comments for specific technologies	• will depend on technologies employed - refer to above comments for specific technologies • will generally, but not always, include cost of battery cycle charging and technology specific costs	• will depend on technologies employed - refer to above comments for specific technologies • reduction in fueled generation source O&M costs due to reduced operating time	• site and system specific • generally 2 - 5 years

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Sources - Cogeneration											
Combined heat and power or co-generation	• depends on type of power source and heat load • depends on proximity of power source to heat loads	• may be less efficient if heat loads vary seasonally	• most efficient in winter	• no foreseeable conflicts	• systems are custom designed and sized • numerous sources in Canada	• reliable	• moderately complex	• generally yes but should be checked with appropriate authorities	• fueled energy source will still require fuel	• savings will depend on primary use (heat/power)	• 10 - 20 years
Energy Sources - Wood Heat											
Wood fueled furnace	• may depend on type and availability of fuel source (wood, pellets) • requires electricity	• not as important in summer (less heat load)	• more efficient in winter	• may be able to optimize with dual fuel units • electricity is required • can operate with other heat sources	• several suppliers and service companies in Alberta and BC	• high	• moderate	• yes, must be installed in accordance with applicable building codes	• wood or pellets	• pellet system extremely efficient • either system will displace other fuel sources	• 10 - 20 years
High efficiency wood stoves, fireplaces	• may depend on type and availability of fuel source (wood, pellets) • may depend on actual heating loads	• not as important in summer (less heat load)	• more efficient in winter	• can operate with other heat sources • may need means of distributing heat throughout building	• numerous suppliers and service companies in Alberta	• high	• moderate	• yes, must be installed in accordance with applicable building codes	• wood or pellets	• pellet system extremely efficient • either system will displace other fuel sources	• 10 - 20 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Sources - Cogeneration											
Combined heat and power or co-generation	• fueled energy system will produce noise • may be visual impact from ducting/piping	• n/a	• impacts same as fueled generation source but overall impact may be reduced due to net increase in efficiency	• impacts same as fueled generation source but overall impact may be reduced due to net increase in efficiency	• reduction in either power or heating costs	• increase in overall efficiency	• increase in complexity may translate into higher O&M costs	• increased complexity • must need both heat and power to be worthwhile	• system specific - will depend on heat and power source, loads, sizing	• higher than stand alone power or heat, but may be less than total of both • may require specialized skill or knowledge	• 6-8 years *
Energy Sources - Wood Heat											
Wood fueled furnace	• none	• pellet furnace - none • wood furnace - may be increased fire hazard (chimney fires)	• pellet furnace - uses waste wood • impacts associated with firewood collection and harvesting	• pellet furnace has very low emissions • wood furnace has high emissions	• pellet furnace more economic than wood • wood furnace - depends on availability and costs of wood source	• pellet type uses waste wood • wood type - may be able to use local source	• tied to a particular fuel supply	• tied to a particular fuel supply	• $2600 - $4000	• pellets $175/ton • wood - variable • other costs very low • wood must be continuously fueled • pellet type can be fueled for longer periods	• site specific
High efficiency wood stoves, fireplaces	• generally visually appealing • frequently part of the 'ambiance' of remote facilities • pellet type has no chimney	• must be constantly fueled (pellet type can be fueled for up to 2 days) • wood type - increased fire hazard • pellet type very safe	• pellet type - uses waste wood • impacts associated with firewood collection and harvesting	• pellet type has very low emissions • wood type has high emissions	• pellet stove more economic than wood • wood stove - depends on availability and costs of wood source	• pellet type uses waste wood • wood type - may be able to use local source	• tied to a particular fuel supply	• tied to a particular fuel supply	• pellet stove: $2000 - $3000 • wood: $1000 - $3000	• pellets $175/ton • wood - variable • other costs very low • wood must be continuously fueled • pellet type can be fueled for longer periods	• site specific

---

* based on figures from Alberta Energy, Energy Efficiency Branch for a typical urban setting, increased energy or fuel costs could significantly reduce this figure

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Efficiency											
Energy Efficiency - Waste Energy Recovery											
Engine heat recovery	• feasible if engines are used, easier with water cooled engines but possible with air cooled	• space heating may not be desired in summer	• appropriate	• no foreseeable conflicts • may reduce other energy requirements	• no specialized suppliers or service required	• uses standard plumbing or ventilation equipment	• the degree of heat recovery desired and the use to which it is put will determine complexity	• should be installed in conformance to building and electrical codes	• none	• may reduce total energy needs	• will depend on life span of plumbing and/or ventilation components utilized
Hot water pre-heat	• requires source of waste heat, eg. wood stove or furnace, engine coolant, etc.	• waste heat may not be as available in the summer	• waste heat may have higher priority uses in winter	• no foreseeable conflicts	• no specialized suppliers or service required	• uses standard plumbing equipment	• the degree of heat recovery and pre-heat desired will determine complexity	• should be installed in conformance to building and electrical codes	• none	• may reduce total energy needs	• will depend on life span of plumbing components utilized
Hot water tank insulation	• yes	• appropriate at any time	• appropriate at any time	• yes	• no specialized suppliers or service required	• high	• simple	• yes	• none	• may reduce total energy needs	• life of tank
Hot tub cover	• feasible	• appropriate at any time	• more effective in winter as greater heat differential and consequent loss	• no foreseeable conflicts	• available from hot tub suppliers	• n/a	• n/a	• yes	• none	• may reduce total energy needs	• depends on quality and use, check with supplier
Clothes dryer heat exchange	• yes	• may not require the heat in the summer	• may have condensation or icing problems in winter	• no foreseeable conflicts	• ??	• ??	• ??	• ??	• none	• may reduce total energy needs	• ??

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Efficiency											
Energy Efficiency - Waste Energy Recovery											
Engine heat recovery	• reduced total energy demands may reduce impacts from energy sources	• use with air cooled engines may introduce fumes, smells	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• increased complexity and O&M requirements	• will depend on sophistication of system installed, costs could start as low as $200 and go up as high as desired	• will depend on sophistication of system installed, but generally should be minimal • reduced energy costs	• will depend on the degree of heat recovery attained and costs of doing so • 5-10 years*
Hot water pre-heat	• reduced total energy demands may reduce impacts from energy sources		• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• increased complexity and O&M requirements	• will depend on sophistication of system installed, costs could start as low as $200 and go up as high as desired	• will depend on sophistication of system installed, but generally should be minimal • reduced energy costs	• will depend on the degree of heat recovery and pre-heat attained and costs of doing so • 0.5 - 3 years
Hot water tank insulation	• reduced total energy demands may reduce impacts from energy sources		• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• none	• will depend on size, number and type of tank, but can start as low as $100	• none • reduced energy costs	• 1 - 3 years*
Hot tub cover	• reduced total energy demands may reduce impacts from energy sources	• may increase water safety	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts • cleaner water	• initial capital costs	• must be manually put in place when tub is not in use	• will depend on size and shape of tub, individual suppliers can provide costs	• will depend on sophistication of system installed, but generally should be minimal • reduced energy costs	• 0.3 - 1 year *
Clothes dryer heat exchange	• reduced total energy demands may reduce impacts from energy sources		• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• must be cleaned, possibility of condensation, icing problems	• unknown	• reduced energy costs	• unknown

---

* based on figures from Alberta Energy, Energy Efficiency Branch for a typical urban setting, increased energy or fuel costs could significantly reduce this figure

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Efficiency - Lighting											
Lighting control	• feasible for electrical lighting, not applicable for gas or propane lighting		• more important in winter as fewer daylight hours	• no foreseeable conflicts	• numerous suppliers and service companies in Alberta	• depends on quality used but generally high	• depends on degree of control utilized, can be as simple as a photocell to a full range of timers, motion detectors and intensity adjustment	• must be installed in accordance with CSA and CEC	• none	• may reduce total energy needs	• depends on specific system installed, but generally 5 - 20 years
Light fixtures (reduce number, fluorescent, compact fluorescents, high eff. ballasts)	• feasible for electrical lighting, reduction and smaller sizes possible for gas or propane lighting		• more important in winter as fewer daylight hours	• no foreseeable conflicts	• numerous suppliers and service companies in Alberta	• depends on quality used but generally high	• no different than conventional lighting	• must be installed in accordance with CSA and CEC	• none	• may reduce total energy needs	• depends on specific fixtures installed, but generally same or better than conventional • 2 to 10 years
DC lighting	• separate wiring required • retrofit could be prohibitively expensive • if battery storage is used in power system, increase in efficiency as power for lights would not have to be inverted to AC		• more important in winter as fewer daylight hours	• no foreseeable conflicts	• several suppliers and service companies in Alberta	• depends on quality used but generally high	• separate wiring system would be required	• strict adherence to applicable electrical codes required	• none	• may reduce total energy needs	• bulbs and lamps generally last twice as long as AC equivalents
Day lighting	• must be considered in design of buildings • need to balance energy savings against heat loss/gain through windows	• could increase heat gain	• more important in winter as fewer daylight hours and lower sun angle • could increase heat loss	• could increase heat loss/gain through windows • could have impact on passive solar design	• several design firms and consultants in Alberta	• n/a	• may be increase in complexity of building design	• must meet applicable building codes	• may require energy to counter heat loss/gain	• can reduce daytime lighting needs	• life of building

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Efficiency - Lighting											
Lighting control	• reduced total energy demands may reduce impacts from energy sources	• lower light levels may cause seeing difficulties for some • systems must be such that a safety hazard is not created due to darkness	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• possible inconvenience	• depends on degree of control required can start as low as $50 for a photocell control to several thousand for a complete control system including timers, motion detectors, etc.	• minimal • reduced energy costs	• 0 - 8 years*
Light fixtures (reduce number, fluorescent, compact fluorescence, high eff. ballasts)	• reduced total energy demands may reduce impacts from energy sources	• light from fluorescents may be 'harsher' than incandescent • reduced lighting may cause visibility problems	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• possible inconvenience	• depends on fixtures selected • reduction in number of lights may reduce costs • $300 - $1500/kW	• maintenance no different than conventional lighting • bulb or lamp replacement is less frequent so O&M may be reduced • reduced energy costs	• 1 - 9 years*
DC lighting	• reduced total energy demands may reduce impacts from energy sources	• DC circuits are more hazardous than AC but this can be offset by proper installation	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• separate DC wiring required • not all electricians familiar with DC wiring	• 2 - 3 times that of AC lighting	• maintenance no different than conventional lighting • bulb or lamp replacement is much less frequent so O&M may be reduced • reduced energy costs	• 1 - 2 years
Day lighting	• can be incorporated into building design to be aesthetically pleasing	• can provide better daytime light, increase 'airiness' of interior, etc.	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• may increase building costs		• could be increased building costs for extra windows, or other design aspects • facility specific	• possible increase in window cleaning requirements	• facility specific

---

* based on figures from Alberta Energy, Energy Efficiency Branch for a typical urban setting, increased energy or fuel costs could significantly reduce this figure

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Efficiency - Appliances											
Efficient appliances (including low temp dishwashers, cold rinse clothes washers, induction ranges, convection ovens, walk-in freezer strip curtains, etc.)	• yes as long as specific appliance is compatible with facility			• possible interaction with water/ sewage technologies and practices	• numerous suppliers and service companies in Alberta	• standard appliance industry reliabilities	• generally no more complex than standard appliances	• yes	• specific to appliance	• specific to appliance	• typically 5 - 10 years
Gas ranges and dryers	• feasible if fuel source present			• if need for gas storage and transport has been eliminated or is not needed by other technologies this may not be a reasonable alternative	• numerous suppliers and service companies in Alberta	• standard appliance industry reliabilities	• generally no more complex than standard appliances	• yes	• specific to appliance	• specific to appliance, but would be a net energy cost reduction over electrical alternative, due to less energy conversion	• typically 5 - 10 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Efficiency - Appliances											
Efficient appliances (including low temp dishwashers, cold rinse clothes washers, induction ranges, convection ovens, walk-in freezer strip curtains, etc.)	• reduced total energy demands may reduce impacts from energy sources	• none	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• none	• varies with appliance, typically 0 - 50% more	• same as conventional, except for reduced energy costs	• 1 - 6 years*
Gas ranges and dryers	• reduced total energy demands may reduce impacts from energy sources	• none	• reduced total energy demands may reduce impacts from energy sources	• air emissions due to burning of gas • due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs		• initial capital costs	• air emissions from fuel burning	??	• fuel costs based on appliance fuel consumption	• 1-5 years*

---

* based on figures from Alberta Energy, Energy Efficiency Branch for a typical urban setting, increased energy or fuel costs could significantly reduce this figure

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services)	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Efficiency - Heating											
Temp. setback	• yes, as long as comfort is not highest priority • if heating is by source not automatically controlled (eg. wood stove) then this is not relevant	• can be used with air conditioning if this is present	• can be used with all thermostat controlled heat sources	• yes unless ambient temperature is important (unlikely)	• automatic controls are available from numerous suppliers in Alberta • manual control requires no equipment	• high	• automatic control slight increase	• approved controllers should be used	• none	• will depend on degree of setback and weather	• 20 years
Hot water temp. setback	• yes unless a certain temperature is required for some reason			• may cause more energy use by appliances that need to have water at certain temp (eg. dishwasher) • may affect technologies/practices that require water of a certain temp.	• n/a	• n/a	• n/a	• should ensure that lower water temp does not affect dishwasher sterilization process	• may be some energy requirements by equipment that requires certain water temps	• reduced energy costs	• n/a
Low flow shower heads	• yes if sufficient water pressure present			• may assist water conservation technologies/ practices • if other technologies reduce water pressure this may not be applicable	• universally available	• n/a	• simple	• n/a	• none	• reduced water heating requirements	• depends on water quality (5-20 years)
Heat pumps	• yes as long as electricity available	• can provide air conditioning	• can provide heating	• no foreseeable conflicts • can also provide efficient water heating	• several suppliers and service companies in Alberta	• normal heating system reliability	• more complex than typical furnace	• yes, equipment must meet applicable codes	• electricity and or gas	• more efficient than standard furnace/air cond. therefore reduction in energy needs • can also provide efficient water heating	• 10 to 20 years
Efficient furnaces	• yes if energy source(s) available	• energy savings if furnace turned off in summer	• yes	• yes as long as other technologies allow use of required energy sources	• numerous suppliers and service companies in Alberta	• normal heating system reliability	• no more complex than typical furnace	• yes, equipment must meet applicable codes	• electricity and or gas	• more efficient than standard furnace/air cond. therefore reduction in energy needs	• 10 to 20 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Efficiency - Heating											
Temp. setback	• reduced total energy demands may reduce impacts from energy sources	• may cause some discomfort due to cooler/warmer temperatures, however these can be kept in normal comfort ranges	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• none unless automatic time of day control used	• possible slight discomfort	• none unless automatic time of day control used ($50-$500)	• reduced energy costs	0 - 1 years*
Hot water temp. setback	• reduced total energy demands may reduce impacts from energy sources	• generally unnoticed • higher safety (less scalding danger)	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• none	• low water pressure may cause poor performance	• zero	• reduced energy costs	1 - 3 years*
Low flow shower heads	• reduced total energy demands may reduce impacts from energy sources	• usually unnoticeable unless water pressure low	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs				• $5 - $20 each		
Heat pumps	• reduced total energy demands may reduce impacts from energy sources	• can provide air conditioning if desired	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts • air conditioning available • efficient water heating possible	• initial capital costs	• none	• $1000 - $5000 more than standard furnace	• reduced energy costs • can reduce water heating costs	
Efficient furnaces	• reduced total energy demands may reduce impacts from energy sources	• none	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• none	• ??	• reduced energy costs • no increase over standard furnace costs	• 0.6 - 9 years

---

* based on figures from Alberta Energy, Energy Efficiency Branch for a typical urban setting, increased energy or fuel costs could significantly reduce this figure

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services)	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Efficiency - Load Management											
Energy management systems	• yes, the degree of sophistication will depend on energy savings desired, complexity of total energy system and acceptable costs	• appropriate	• appropriate	• system may control operation of other technologies, must ensure that this does not negatively impact their effectiveness or operation	• numerous suppliers, designers, service companies in Alberta	• depends on quality and complexity, but generally high	• can range from very simple (timer) to very complex (direct digital control automation)	• yes	• none	• reduced energy use	• 5 - 20 years
Energy management practices (reduce appliances, manually reduce loads, etc.)	• yes	• appropriate	• appropriate	• must ensure that this does not negatively impact the effectiveness or operation of other technologies	• n/a	• variable • requires conscientious practice by facility operators and/or guests	• can range from reminders to turn off lights, to restricting use of hair dryers to conscious decision not to use certain appliances or conveniences	• n/a	• none	• depends on the degree of action taken but can be significant	• n/a
Power factor improvement	• yes, if electrical system present which generates 3 phase power	• appropriate	• appropriate	• yes as long as 3 phase power present	• requires electrician	• yes if properly done and changed when electrical load sources are changed	• could increase complexity of wiring	• yes, in fact encouraged by codes	• none	• reduced overall loads will result in net savings	• as long as configuration of electrical loads remains the same
Energy efficient motors (pumping, ventilation, etc.)	• yes as long as motors are used in facility	• appropriate	• appropriate	• yes, can replace motors used in other technologies	• numerous suppliers in Alberta	• as or more reliable than standard motors	• no more complex than standard motors	• yes	• electricity	• more efficient, resulting in energy savings (5 - 20%)	• 10 - 20 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Efficiency - Load management											
Energy management systems	• no visual or noise impacts	• potential for some inconvenience, may need to schedule certain activities	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• may create inconvenience, scheduling problems	• from $50 to $1,000's depending on sophistication of system	• reduced energy costs • minimal	• 0.5 - 20 years
Energy nanagement practices (reduce appliances, anually reduce loads, etc.)	• no visual or noise impacts	• may create inconvenience • may mean that certain facilities or activities are not available	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• has to be consciously practiced	• zero	• reduced energy costs • zero	0 years
Power factor improvement	• none	• none	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• may increase electrical system complexity	• depends on complexity and size of electrical system and the various loads • $200 to $1000's	• reduced energy costs • none	• 1 - 3 years*
Energy efficient motors	• none	• none	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• none	• 5 - 20% more than standard motors	• reduced energy costs • same as standard motors	• 2 - 6 years*

---

* based on figures from Alberta Energy, Energy Efficiency Branch for a typical urban setting, increased energy or fuel costs could significantly reduce this figure

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services)	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Efficiency - Transport											
Reduce motorized transport requirements	• yes, if efficient scheduling, material use and waste management can be applied or if non-motorized alternatives available	• appropriate • a more efficient mode of transport may be suitable only a particular season	• appropriate • a more efficient mode of transport may be suitable only a particular season	• will rely in part on waste management strategy	• n/a	• depends on reliability and skill of facility operator • may depend on reliability of non-motorized transport	• scheduling and planning may become more complex	• n/a		• reduction in motorize requirements will reduce fuel needs	• n/a
Reduce air transport requirements	• yes, if efficient scheduling, material use and waste management can be applied or if non-air alternatives available • there may not be any alternatives in some instances	• appropriate • a more efficient mode of transport may be suitable only a particular season	• appropriate • a more efficient mode of transport may be suitable only a particular season	• will rely in part on waste management strategy	• n/a	• depends on reliability and skill of facility operator • may depend on reliability of non-air transport	• scheduling and planning may become more complex	• n/a	• fuel required for air transport • requirements will depend on degree of reduction achieved	• any reduction in air transport use will result in less fuel consumption • savings will depend on degree of reduction achieved	• n/a

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Efficiency - Transport											
Reduce motorized transport requirements	• will reduce noise and visual impact of motorized transport	• may mean more physical labour in transportation • may mean guests have to transport themselves by foot or wait for scheduled transport	• decreased impact on wildlife • possible decreased impact on road or trail (erosion, vegetation disturbance, etc.)	• reduced emissions and waste from vehicles	• may reduce transportation costs • will reduce fuel and maintenance costs	• less impact due to reduced traffic	• alternatives may be more costly or labour intensive	• may inconvenience guests • may increase scheduling complexity	• depends on alternative chosen	• reduced costs for motorized transport • may be other costs depending on alternative chosen	• facility specific (may not pay back)
Reduce air transport requirements	• will reduce noise and visual impact of air transport	• may mean more physical labour in transportation • may mean increased motorized transport • may mean guests have to transport themselves by foot or wait for scheduled transport	• decreased impact on wildlife • possible increased impact on road or trail if motorized transport used as alternate (erosion, vegetation disturbance, etc.)	• reduced emissions and waste from air transport • may mean increased motorized transport	• may reduce air transportation costs but may increase motorized transport costs • will reduce fuel and maintenance costs of air transport but may increase motorized costs	• less impact due to reduced air traffic	• alternatives may be more costly, time consuming or labour intensive	• may increase motorized traffic • may cause inconvenience	• depends on alternate chosen	• depends on alternate chosen	• depends on alternate chosen • due to expense of air transport any reduction in use should result in significant savings however these may be offset (in whole or part) by other costs

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services)	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Energy Efficiency - Building Efficiency											
Airtight-ness (vapour barriers, weather-ripping, entry porches, etc.)	• most easily accomplished during building design and construction but some elements are possible as retro-fit	• not a major concern	• important for heat loss in winter	• will reduce heating loads and therefore total energy consumption	• numerous suppliers in Alberta • tecniques standard to construction industry	• high if properly designed for condensation and icing	• may increase complexity of construction	• must meet building code specifications	• none	• reduction in heat loss will reduce energy costs	• 2 years to life of building
Air to air heat exchange	• yes if forced air type heating is used	• inappropriate	• appropriate	• will reduce heating of ambient air and therefore total energy consumption	• several suppliers in Alberta	• high if properly installed	• simple	• must meet building code specifications	• none • some designs may require electricity	• reduction in heating of ambient air will reduce energy costs	• unknown
Windows (low-E, triple glazing, argon-filled, superwindows)	• yes	• reduces heat gain	• reduces heat loss	• will reduce heating/cooling loads and therefore total energy consumption	• several suppliers in Alberta	• high	• n/a	• exceed building code requirements	• none	• reduction in heat loss/gain will reduce energy costs	30 years
Insulation/ shutters	• yes, especially if installed during construction	• reduces heat gain	• reduces heat loss	• will reduce heating/cooling loads and therefore total energy consumption	• numerous suppliers in Canada	• high	• shutters may increase need for manual operation and attention	• must meet or exceed minimum code requirements	• none, unless automatically operated shutters used	• reduction in heat loss/gain will reduce energy costs	• insulation - life of building • shutters - up to 30 years
Passive solar design (incl. thermal energy storage, ventilation, shading, etc.)	• yes, but generally must be undertaken during design of facility • limited retro-fit possible	• reduces heat gain in summer	• reduces heat loss in winter	• may impact other energy efficiency technologies	• several designers, engineers and architects in Alberta	• high if designed properly	• could increase complexity of construction	• must meet applicable codes	• some aspects may increase energy requirements	• reduction in heat loss/gain will reduce energy costs	• generally life of building

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Energy Efficiency - Building Efficiency											
Airtight-ness (vapour barriers, weather-ripping, entry porches, etc.)	• n/a	• may reduce discomfort caused by drafts	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• may increase construction complexity	• variable depending on degree of airtightness desired • generally will be a nominal increase in construction costs	• reduced energy costs • none specific to materials	• 1 - 5 years*
Air to air heat exchange	• n/a	• if blocked by ice may affect indoor air quality	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• initial capital costs	• possibility of icing and condensation problems	• unknown	• unknown	• unknown
Windows (low-E, triple glazing, argon-filled, superwindows)	• n/a	• n/a	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs (1 - 40%)	• reduced environmental impacts	• initial capital costs	• costly to replace if damaged	• average $300 - $500 unit cost over standard	• reduced energy costs	• unknown
Insulation/ shutters	• shutters may have some visual impact	• shutters may block view or internal light	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs (0.1 - 60%)	• reduced environmental impacts	• initial capital costs	• shutters may affect daylighting or views	• building specific	• reduced energy costs	• variable
Passive solar design (incl. thermal energy storage, ventilation, shading, etc.)	• if aesthetics are not considered during design could have negative impact, however design can be such that a positive impact can be acheived	• proper design will avoid any comfort loss	• reduced total energy demands may reduce impacts from energy sources	• due to reduced energy needs may reduce impacts of energy sources	• reduced energy costs	• reduced environmental impacts	• possible initial capital costs	• may be conflicts between energy design and functional design	• highly variable depending on degree of solar based efficiency attained • many design changes will not affect costs	• reduced energy costs • design features generally will not have a specific O&M costs	• highly variable (0 - ∞)

---

* based on figures from Alberta Energy, Energy Efficiency Branch for a typical urban setting, increased energy or fuel costs could significantly reduce this figure

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Sources and Treatment											
Water Sources											
Drilled wells	• known ground water source must be available	• appro-priate year round	• appro-priate year round	• compatible with other technologies • may require iron, manganese removal and softening	• remote heli-portable rigs available; breakdown to 3000 lb pieces (7-10 pieces)	• will vary based on ground water supply • pumps and electrical controls add complexity	• simple submersible pump • will require pressure tank and may require disinfection with chlorine	• good but must check with local authority • exploration permit, water withdrawal licenses, and restricted development area approvals may be required by Alberta Environmental Protection	• single phase 120 or 240 VAC electrical power	• less intensive treatment system than surface water systems • can be in close proximity to site	• 20 years • determined by tests and scale of withdrawal
Surface streams/ infiltration galleries	• depends on distance to water source and quality/ quantity of supply	• quality may change with run-off and storms	• source must not freeze in winter	• compatible • may require extensive treatment to assure quality	• will be designed on site specific basis	• base on stream flow records	• gravity fed systems are simple and reliable • mechanical systems more complex	• must meet Alberta Environmental Protection and Canadian Drinking Water Standards and Guidelines • water withdrawal license and restricted development are approvals that may be required by Alberta Environmental Protection	• gravity systems • none • pumped systems single phase 120 or 240 VAC electrical power or larger head pumps may need 3 phase	• power costs on gravity systems	• determined by scale of development and source

Appendix A
Table 2 - page 1a

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Sources and Treatment											
Water Sources											
Drilled wells	• good; unobtrusive and quiet	• good	• will drawdown ground water table over time	• n/a	• less intensive treatment system • low O&M costs	• unobtrusive	• low flow wells may need large on-site storage cisterns • cost of flying in rig and crews • pilot hole test costs • need pressure tank in lodge • number of wells will vary with source	• wells at distance from lodge will require transmission line	• $70 per cased meter in good conditions (no rock) • $2000 per well plus move in/move out costs typical • remote sites could run $20,000 -$30,000 depending on no. of wells, crews and degree of remoteness • very site specific depending on groundwater depths and flows	• power consumption of submersible pump $100 - $1000 per year • pump maintenance • will vary with complexity and number of system components (eg. pumps, pressure tanks, submersible)	• n/a
Surface streams/ infiltration galleries	• transmission lines may impact landscape • inlet structures can be designed to be unobtrusive • construction may require large backhoes and other equipment (ie. ditch witch)	• good	• will depend on volume of stream flow and percent of flow withdrawn	• con-struction can impact fish/wildlife habitat and surrounding area	• gravity systems are low maintenance	• typically a reliable and predictable source	• large distances from source requires costly construction with large equipment	• stream water quality and quantity can vary over year	• will vary with inlet size and type, stream size, distance to stream, etc. • very site specific	• power consumption costs $100 - $1000 per year • will vary with power supply	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Sources											
Rainwater collection	• feasible in arid regions only if storage and precipitation are sufficient • less common in Alberta where ground and surface sources are available	• appro-priate for summer seasonal use	• will not operate in cold regions	• may be used to supplement other sources of water	• not common in Alberta	• varies with seasonal precipitation which can be very unreliable in some regions • actual collection system reliable	• single catchment system • if gravity tank used, very simple • if pumped system, then power, pump and tank required	• may be reviewed by Alberta Labour and Environmental Protection • generally not a problem, though reliability of source would be of concern	• re-pumping from cistern would require single phase 120 or 240 VAC power	• raw water source pumping energy costs	• 10-20 years depending on design
Fresh water hauling	• best applied in areas close to good supplies and where air transport is readily available • larger tanks can reduce hauling frequency	• good • weather may be a problem	• good • weather may be a problem	• good • can be used to supplement other sources in emergencies or on regular basis	• readily available	• generally reliable provided extended weather problems do not inhibit transport by helicopter or land	• simple system consists basically of a storage tank or cistern and re-pumping facility	• should not be a problem • will be reviewed by Alberta Labor and Alberta Environmental Protection • local authority may be contacted with respect to noise by-laws and/or site access restrictions	• air or land based vehicle fuel requirements will be high • helicopter fuel changes will vary with frequency and duration of flights	• relatively minute compared to costs of transport	• indefinite

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Sources											
Rainwater collection	• large catchment traps may be obtrusive • no noise	• low impact	• low impact on biophysical environment at scale being discussed	• n/a	• could theoretically utilize roof systems already constructed	• low impact on surrounding environment	• may require supplemental supply to maintain reliability in large 25-70 person lodgings • will require large storage volumes	• reliability is totally dependent on frequency and probability of rain events	• not readily available • impoundment storage or cistern costs could be very high to maintain storage between rain events	• re-pumping costs from cistern $100 - $1000 per year	• n/a
Fresh water hauling	• daily flights by helicopter can disturb occupants and wildlife • overland routes can damage terrain	• ideally schedule flights for least impact hours • relatively high risk transportation	• relatively unsustainable due to high energy to water consumption costs • overland routes by ATV etc. can damage terrain environment	• n/a	• can avoid costly capital investment on temporary sites • does not require treatment though rechlorination may be required if stored for extended periods	• relatively low impact on surrounding terrain • small space requirements	• high energy consumption	• short duration noise from aircraft and land vehicles • landing location or transport routes must be established • can be affected by poor weather	• on-site tanks and cisterns can vary from $5,000 -$15,000 installed (not including transport to site) • relatively inexpensive capital cost	• re-pumping costs from cistern or tanks $100 -$1000 per year • maintenance could be very small if gravity tanks are utilized	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Treatment Systems											
Pressure vessel filter systems components: • iron and manganese removal • activated carbon filter • multi-media filter • softener • chlorine contact time tanks	• most feasible if ground water source available • also used with surface waters but Alberta Environmental Protection may require reliable membrane filtration downstream to allow removal of any Giardia cyst • number and type of vessels required will depend on raw water quality	• good	• good • must be in heated area of building	• often used with groundwater systems to remove iron and manganese as well as hardness, taste and odor • can be used as pre-treatment for other processes such as reverse osmosis systems • will require chlorination systems	• locally available	• good • replacement parts readily available	• simple tank and valve assembly is designed to meet peak hour flows • filters may be sized smaller to provide only peak day flows into a storage tank, but a separate re-pumping facility and the storage tank must be provided and will increase the complexity	• can meet Alberta Environmental Protection Standards • may require dual membrane filter downstream of media filters to remove Giardia cysts • chlorine contact time must be acceptable to Alberta Environmental Protection	• on groundwater system can operate off of the well's submersible pump pressure • on surface water system can operate off of the raw water system pressure if it is sufficient • if a storage tank and repressurizing system is provided, then a 120 or 240 VAC single phase power source is required to re-pump	• do not have to re-pump if directly fed off of raw water system	• 15 to 20 years • media and valves may need to be replaced sooner

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Treatment Systems											
Pressure vessel filter systems (components: • iron and manganese removal • activated carbon filter • softener • chlorine contact time tanks)	• small and compact • can be located in room in lodging facility	• good	• low impact • creates backwash water to be treated	• n/a	• small economical component system • components can be added or taken away easily • weight of units relatively small; will facilitate transport to site • relatively simple installation and construction	• relatively small space requirements	• can become expensive and cumbersome if facility expands	• n/a	• for 25 person facility each component tank would be approximately $1200 - $1500 supplied • for 70 person facility each component tank would be approx. $2800 -$ 3200 • above cost based on meeting peak hour demand • chlorine contact tanks costs would be $1500 - $3000 • cartridge for giardia removal $150 - $250 • bladder tank $500 - $1000 • chlorination tank and pump $1500 • prices do not include installation nor transport to site	• chlorine and regeneration chemicals will vary with incoming water quality and size of plant • periodic operator involvement	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Treatment Systems											
Package water treatment plants (including coagulation, flocculation, clarification and filtration)	• at small flows (ie. 25 person scenario) may not be economical • generally good but will require extensive daily operator involvement	• good	• good • should be housed in heated facility	• no forseeable incompatibilities • allows flexibility of treatment even with changing raw water quality	• numerous local suppliers	• generally reliable but numerous mechanical control valves and mechanical equipment require at least weekly operator attention	• the mechanical system and the chemical treatment process are relatively complex • trained and certified operator required	• acceptable to Alberta Environmental Protection	• mixers, chemical pumps and automatic controls require single phase 120 or 240 VAC power	• n/a	• 20-30 years • mechanical components 15 years
Slow sand filters	• most feasible when operation is continuous; less effective for intermittent operations	• good	• good • should be housed in heated facility	• no foreseeable incompatibilities	• relatively good	• very reliable • intermittent operation can upset the waterborne biological treatment population	• very simple passive gravity system	• acceptable to Alberta Environmental Protection	• chemical chlorine pump will require single phase 120 or 240 VAC power	• if gravity can be used will cut down on pumping costs	• 20-30 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Treatment Systems											
Package water treatment plants (including coagulation, flocculation, clarification, and filtration)	• mixer motors can be noisy • best to house in separate insulated room or heated building	• safe proven system promoted by the regulatory bodies	• backwash and clarifier sludge must be treated and/or disposed	• n/a	• long on major components • compact size approx. 3m^2	• excellent flexibility in providing treatment with varying raw water quality • proven treatment methods widely used in North American • intermittent operation possible	• requires coagulation chemicals on an ongoing basis • will require peak day storage on-site • 25-70 person aluminum plant weights vary from 2600 lb to 3200 lb (1200 kg to 1500 kg) requiring medium duty helicopters to fly in	• desludge and backwash adds to waste treatment requirements	• supply cost for 25 person scenario approx. $25-30,000 • supply cost for 70 person scenario approx. $35-40,000 • concrete pad, heated enclosure, storage tank, installation and transport cost vary	• chemical costs in the order of $0.25 to $0.50 per 100 Igal (4500 l) or aprox. $500 - $1500 annually • power costs on mixing motors $100 - $1000	• n/a
Slow sand filters	• quite • best to house in heated enclosure or building • relatively large area required	• good reliable passive system	• no continuous backwash nor clarifier sludge discharges • periodic removal of top layer of filter required	• n/a	• lower chemical costs • long life of components • can utilize pre-cast or cast in place concrete or steel tank design • light weight fibreglass tank may be considered	• passive low energy system	• larger space and enclosure requirements • requires peak day storage on-site • media may have to be imported to site	• size varies from 10 m^2 to 30 m^2 for 25 to 70 person scenario	• will vary with site conditions and design • with steel tank enclosure supply costs in order of $25-35,000 • heated enclosure installation and transport costs vary	• chlorine disinfecting costs relatively low • periodic (2-6 month) removal of very top layer of filter sand	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Treatment Systems											
Reverse osmosis and "nana" micro filters	• will treat both surface and ground supplies • ground supplies high in iron may require pre-treatment with pressure tank filters to prevent premature membrane replacement • pilot study on actual raw water would be advisable	• good	• good	• no foreseeable incompatibilities • raw water quality one of most important factors	• numerous local suppliers	• varies with incoming raw water quality • water analysis a necessity to determine effectiveness of system • may need to replace filters frequently if incoming quality poor	• relatively few mechanical parts • availability of local expertise important to assist in system maintenance	• acceptable to Alberta Environmental Protection • should check with local authorities	• single phase 120 or 240 VACelectric power	• n/a	• 20 - 25 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Treatment Systems											
Reverse osmosis and "nana" micro filters	• good; can be housed in building	• n/a	• operates on a purge type system which will require more raw water than produced treated water (ie. inefficient water use) • filtered sludge must be treated and/or disposed	• n/a	• relatively light weight and compact • relatively low capital cost	• relatively light to move on site: 130 kg for 25 person, 150 kg for 70 person • can achieve high degree of treatment	• can have high operation and maintenance costs • requires heated building enclosure • intermittent operation may degrade membrane	• can be susceptible to changes in raw water quality which make membrane replacement costly and frequent	• supply costs $12,000 for 25 person scenario and $18,000 for 70 person • chlorinator $1500-$2000 • installation, housing, and transport costs not included	• replacement of filter costs $2000-$3000 every 1 to 3 years • power costs $100 to $1000 per year	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Sources and Treatment											
Water Conservation											
Retrofit devices for conventional toilets (includes tank bottles, improved float assemblies, dams, weights, dual flush mechanisms)	• feasible for existing systems • less appropriate for new facilities	• good	• good	• good	• good	• will vary based on design of conventional toilet and flush efficiency	• relatively simple retrofits	• good	• none	• water and pumping costs	• 10-15 years
Outhouse and portable outdoor toilets	• less feasible for large continuous operation facilities	• odors will be unpleasant	• can be uncomfortable and cold	• conventional pit may affect groundwater	• good	• good	• very simple	• widely used though local authority may regulate location and proximity to development	• none	• pumping and treatment costs	• 10-15 years • must be moved periodically to new sites

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Sources and Treatment											
Water Conservation											
Retrofit devices for conventional toilets (includes tank bottles, improved float assemblies, dams, weights, dual flush mechanisms)	• n/a	• some toilets operate less effectively with reduced tank volume • may irritate users if flush not adequate	• reduces water consumption	• n/a	• reduces water used per flush • low cost	• improves use of existing facilities	• some older toilet designs will not be effective with devices and actually increase consumption by additional flush requirements	• bricks used in tanks can break down and disrupt operation	• $5-$25 per unit	• none	• less than one year typically
Outhouse and portable outdoor toilets	• relatively unattractive	• must be located away from lodging to prevent odor irritation • must be close enough for good access	• pit type can contaminate groundwater	• n/a	• low cost	• portable • quick to assemble	• n/a	• unpleasant odors, inconvenient access, cold in winter • in chemical toilets maintenance removal of waste can be frequent and unsanitary	• $200-$1000 per unit	• low cost on pit type • portable type chemical costs $50-$100 per unit	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Conservation											
Composting	• better on small systems with small tanks	• good	• good when in heated basement or above ground enclosure	• good	• information not available at time of publishing	• good	• simple	• generally good; check with local authority	• none	• water pumping costs	• 10-15 years
Grey water recycling	• often not cost effective	• good	• good	• good	• uncommon in Alberta	• require maintenance	• somewhat complex	• should be good, Alberta Labor should be contacted	• single phase 120 or 240 VAC for motors and pumps	• saves on clear water pumping and treatment	• 10-15 years
Low flow toilets (ultra low flush 6 litres or less)	• good	• good	• good	• good	• readily available	• good	• simple	• good	• none	• reduce water pumpage	• 15-20 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Conservation											
Composting	• none if in basement or above ground enclosure	• house in well ventilated basement or above ground enclosure • vent hook up required	• produces fertilizer	• n/a	• saves on water and power use • no moving parts/low maintenance	• low impact on environment	• high initial cost • units are large for 25-70 persons	• can cause odors if improperly cared for • may not work well if exposed to cold or high altitude	• smaller units for individual domestic buildings run $2,000-$4,000 • for 25-70 scenario costs could be 5-15 times greater	• low	• n/a
Grey water recycling	• good • integrated with plumbing	• good	• reduces water consumption	• n/a	• saves on fresh water use	• reduced withdrawal from raw water source	• high initial costs and maintenance costs • requires filter, tank disinfectant, dye, pumps and power	• can increase the effluent concentration in the waste water system	• $20,000 -$40,000 to supply and install into plumbing	• cost for disinfectant dyes, etc. • information not available at time of publishing	• n/a
Low flow toilets (ultra low flush 6 litres or less)	• successfully used and promoted in N.W.T. remote areas	• good • same look and performance as conventional flush toilets	• reduces flow from conventional toilet by 70%	• n/a	• uses less water	• sanitary, odourless, easy to repair, relatively inexpensive	• must hook up to pressurized water and gravity sewer system	• uses relatively large amounts of water to move small amounts of waste	• $100-$380 per unit	• varies with cost of treated water	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Water Conservation											
Vacuum toilets	• used in some sites by Parks Canada	• good	• good	• needs power and backup power to run effectively	• locally available	• good provided maintenance carried out	• relatively complex	• good but must check with Alberta Labor and local authority	• minimum 120 or 240 VAC single phase electrical • direct discharge system to an RBC needs 3 phase power	• none	• 10-20 years
Low flow shower heads	• good	• good	• good	• good	• good	• good	• simple	• good	• none	• save water pumping costs and heating costs	• indefinite
In-line flow controls	• will vary with performance of conventional downstream devices	• good	• good	• will vary with downstream devices	• good	• good	• simple	• good	• none	• saves on water pumping and heating costs	• indefinite

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Water Conservation											
Vacuum toilets	• noisy	• good • similar to conventional toilet	• reduces water consumption but will concentrate effluent for wastewater treatment process	• n/a	• reduces water treatment and pumping • small diameter piping used	• can be used for multi-unit facilities	• complex operation and high initial costs • needs backup pumps and power	• noisy • need qualified installation personnel	• individual medium use building $5000 - $8000 • for 25 to 70 persons can vary from $30,000 to $60,000	• costs not available • costs include water and electricity costs	• n/a
Low flow shower head	• good	• good	• reduce consumed water and energy to heat water	• n/a	• reduce consumed water (hot and cold) • showers are quick efficient means of cleansing • can regulate water use by time	• good designs perform as well as conventional designs	• slightly more expensive than conventional heads	• lower flows may be noticeable by some users	• $5 - $30	• water consumption and wastewater treatment	• n/a
In-line flow controls	• good	• some conventional appliances will not operate well at low flows	• reduces water and energy use	• n/a	• reduced water and energy use	• n/a	• may increase use of water in poorly operating devices	• n/a	• $1 - $20	• water consumption and wastewater treatment	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Sewage Treatment Systems											
Wastewater Treatment											
Effluent holding tanks	• easy access to helicopter or land route • common in some small National Park facilities	• good	• good • weather conditions a factor	• good	• good	• good • based on relatively good weather for transport	• system simple	• good • may need local authority approval for tanks	• air or land based vehicle fuel requirements are high • fuel charges will vary with frequency and duration of flights	• relatively minute compared to costs of transport	• indefinite
Septic tank and septic tile field	• will vary with soil conditions and groundwater levels • parks staff often disapprove of changes to the landscape	• good	• good	• good	• good	• reliable conventional technology • dependent on soil conditions	• simple	• Alberta Labour and local authority regulate • Alberta Environmental Protection becomes involved in restricted or sensitive areas	• none	• no energy required to treat	• 10-20 years • will vary with soil types

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Sewage Treatment Systems											
Wastewater Treatment											
Effluent holding tanks	• daily flights can disturb wildlife and occupants	• schedule flights for low impact hours • high risk transport	• relatively unsustainable due to high energy costs and low efficiency • overland routes can damage terrain environment	• n/a	• can avoid costly capital investment on temporary sites • no treatment facilities required	• low constructed facility impact on surrounding terrain	• high energy consumption	• short duration noise from aircraft and land vehicles	• on-site tank systems can vary in cost from $5000-$20,000 (not including transport to site)	• transport costs will vary with mode (air or land), frequency, and distance	• n/a
Septic tank and septic tile field	• some odor can be generated in tank • no noise	• locate away from building to prevent odor problems	• can impact groundwater • tile field installation requires 1200 to 2500 metres of field for the 25 to 70 person scenario; heavy construction equipment and clearing of trees may be required	• n/a	• relatively low capital cost • O and M costs low	• effluent not exposed at ground surface reduces potential to contaminate surface waters	• potential for plugging over time • requires construction excavation equipment on site be flown or land transported to site • sludge must be pumped out annually and disposed or treated	• impact terrain environment • impact on ground water	• in good conditions costs can run from $12-25,000 for the 25-70 person scenario	• sludge pump out and disposal costs will vary with disposal or treatment method (ie. fly out waste, etc.)	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Wastewater Treatment											
Rotating biological contactors (RBC)	• used on numerous remote construction camp sites and alpine resort sites • as a mechanical system requires operator attention	• good	• good • unit must utilize fibreglass cover or be housed in heated building	• good • effluent can be discharged to tile field or if disinfected with U.V. or chlorine can be discharged to spray irrigation or receiving stream	• local suppliers	• relatively good • due to mechanical nature of system regular operator attention is required	• simple on/off operation of system though mechanical rotating discs and other components add to overall complexity	• can meet discharge standards required by Alberta Environmental Protection • add-on components can be utilized for Nitrogen and Phosphorous removal	• single phase 120 or 240 VAC electrical power to operate disc rotation motor	• n/a	• 15-20 years

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Wastewater Treatment											
Rotating biological contactors (RBC)	• relatively large units measuring 2.5 metres by 5.0 meters by 2.5 meters high • can be sunk into ground	• relatively low odors • should be housed in separate heated building or with fabricated fibreglass cover away from lodging facility	• effluent quality quite good • sludge must be pumped out of clarifier every 4 to 6 months and treated or disposed of • may use mechanical sludge thickener as option to reduce volume	• n/a	• reduce downstream tile field construction requirements	• packaged unit • can reduce extent of tile field or downstream facility requirements and impact on environment	• need large helicopter to transport to site • should have relatively experienced operator oversee operation • need heated and ventilated enclosure	• mechanical system needs maintenance attention • 2-4 week start-up period • may need recirculation or seed stock if not operated for prolonged periods	• basic units supplied $20,000 for 25 person and $35,000 for 70 person • fibreglass covers add $7000-$12,000 per unit • heated building, installation, and helicopter transport to site will be very site specific and quite expensive • by U.V. or chlorine required for discharge to spray irrigation or receiving stream may add $2000 to $5000	• basic power consumption to continuously rotate disk $1500 - $3500 • operator involvement on weekly basis may be required	n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Wastewater Treatment											
Passive three component system (emerging technology)	• have been looked on favourably by Parks personnel • rely on novel combination of traditional proven low maintenance treatment systems • emerging technology	• promising	• promising	• no foreseeable incompatibilities	• generally one firm familiar with technology (Kucera Engineers Inc. of Golden B.C.)	• high reliability of passive systems • must assess for intermittent facility operation	• very low complexity • utilizes primary digestor, secondary updraft anaerobic filter and final slow sand filter technologies	• should not be problem though more investigation into process may be required	• none	• energy used in other mechanical systems	• 15 to 20 years anticipated
Living machines (emerging technology)	• an emerging technology • currently on trial in Ontario • rely on diverse biological populations	• promising	• promising • units must be housed in approx. 50 m^2 to 100 m^2 heated green house building	• no foreseeable incompatibilities	• generally one firm familiar with this specific process (Living Technologies Inc., Vermont, U.S.A.)	• with knowledgable operator reliability of the relatively passive process should be good • must assess for intermittent operation	• once diverse biological population established in numerous clear tanks, process is quite simple • can be scaled up easily	• not yet accepted by regulatory bodies until more research is carried out	• process has none • building must be heated	• energy used in other mechanical systems	• 15-20 years anticipated

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Wastewater Treatment											
Passive three component system (emerging technology)	• no major impacts foreseen	• comparable to traditional septic tank and tile field systems	• effluent quality can be quite high • can use puck chlorinators and dechlorinators to disinfect to receiving streams or irrigation system	• n/a	• one-time capital cost followed by very low to negligible O & M costs • reduced energy costs • no housing or heating requirements	• relatively compact facility compared to septic tank and tile systems, thereby reducing site impacts	• relatively high initial capital cost expected	• more research into performance required	• unavailable at time of publication	• expected operator involvement down to 2-5 days per year • low cost	• n/a
Living machines (emerging technology)	• greenhouse type set-up can be housed within lodge facility	• may need ventilation	• can achieve very high effluent quality to minimize impact • disinfection will be required for discharge to sensitive areas	• requires primary removal of solids and debris	• low energy input though unit process must be located in heated building • high quality of effluent allows for re-use of effluent in toilets to reduce overall discharges by 80-90% • can extend life of tile systems	• utilized diverse bacteriological and aquatic plant population • can achieve very high degree of treatment • can utilize local bacteriological and aquatic population • light weight facility components easy to move into site	• initial capital and continued O & M costs can be high	• more research into performance required	• anticipated $25-50,000 for supply of system • disinfection may add $2000 - $500 to cost • if not discharging to receiving surface stream will need septic tank and small tile field	• unavailable • anticipated operator involvement on weekly basis or more frequent for larger facility	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Wastewater Treatment											
Effluent discharge to wetlands or by spray irrigation	• will be feasible on very site specific basis depending on topography and effluent quality • spray irrigation used on prairie but less popular in alpine parks except where reclamation is required	• good	• spray irrigation not appropriate in cold weather • wetlands discharge on site specific basis	• represents downstream discharge technology compatible with most treatment systems • may be used with tile fields as alternate effluent discharge	• varies	• irrigation system has mechanical components requiring maintenance • wetlands very reliable	• irrigation system can be somewhat complex • wetlands very simple	• Alberta Environmental Protection will accept both on discretionary basis • Parks and local authorities should be contacted	• irrigation would require at least 120 or 240 VAC single phase electric power • wetlands none • irrigation pumps could run on gas, diesel, propane, etc. as well	• relatively slight	• 15-20 years for irrigation and indefinite for wetlands

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Wastewater Treatment											
Effluent discharge to wetland or by spray irrigation	• growth of foliage enhanced	• may locate both away from lodge to prevent odor problems • will depend on quality of effluent	• if effluent loading not excessive impact will be small	• n/a	• an reduce irrigation requirements • can prolong tile field use	• reduces effluent discharge into ground via tile fields	• irrigation systems require high degree of O & M	• can cause growth in excess of natural to change natural area plant growth	• very site dependent on soils and topography	• very site dependent	• n/a

Technology or Practice	Feasibility	Resource Appropriateness/ Availability		Compatibility with other technologies/ practices	Availability (incl. suppliers, services	Reliability	Complexity	Conformance to applicable codes, regulations	Fuel/Energy		Life span
		Summer	Winter						Requirements	Savings	
Waste Management											
Mid-scale composters	• may be site specific constraints due to climate			• depends on effective separation of compostables	• available in Canada • plans available in Alberta • may be 'home built'	• depends on staff maintenance	• simple	• should meet Alberta Environmental Protection guidelines• consult local Board of Health and municipality.	• may require fuel or electricity	• possible fuel savings in reduced waste transport	
Waste compactors	• commercial equipment constrained by ability to transport to site • may be designed for assembly on site			• no problems anticipated.	• available in Canada	• good	• simple	• no requirements	• may require short surges of electrical demand	• indirectly through reduced waste transportation demand	
Wood chippers	• equipment constrained by ability to transport to site			• no problems foreseen	• available in Alberta	• good	• simple	• no requirements	• small amounts of electrical power or liquid fuel consumption	• none	

Technology or Practice	Environmental consequences				Benefits		Disadvantages		Order of Magnitude Costs		Payback period (if known)
	Aesthetics (visual, noise)	Human safety, comfort	Biophysical	Other	Economic	Non-economic	Economic	Non-economic	Capital	Annual O&M	
Waste Management											
Mid-scale composters	• odour if not managed properly		• requires control of wildlife access • may attract problem wildlife • wildlife habituation if access permitted • may require runoff control		• may reduce costs of soil amendments in reclamation	• none known	• small amount of staff time to maintain	• space requirements	• as low as $400 for building materials • up to $12,000 for prebuilt composters • leasing arrangements possible	• staff time	
Waste compactors	• short noise periods				• less waste transportation costs	• less waste storage space required	• none known	• space required	• less than $5000	• low	
Wood chippers	• noise during periods of use				• reduced cost of virgin mulches and chips	• limited erosion protection on trail surfaces • convenient supply of chips	• capital cost	• storage space required for ships and equipment	• less than $5000	• low	

APPENDIX B

WASTE MANAGEMENT OPTIONS FOR MAJOR WASTE STREAMS

Options for specific waste streams may be found on the following pages:

Batteries - Dry Cell .... B - 2
Batteries - Lead Acid .... B - 2
Cleaners - Lodge, Equipment And Shop Cleaners .... B - 3
Construction And Landscaping Wastes .... B - 5
Filters .... B - 7
Fuels - Compressed Gases .... B - 8
Fuels - Liquid Petroleum .... B - 9
Fuels - Solid .... B - 10
Glass .... B - 11
Metal .... B - 12
Oils - Machine Applications .... B - 13
Oils And Grease - Cooking .... B - 15
Organics .... B - 16
Paper Products .... B - 17
Plastic Containers .... B - 19
Tableware .... B - 20

BATTERIES - DRY CELL

Examples:	Flashlight and radio batteries.
Potentially hazardous:	No
Discussion:	Many dry cell batteries contain mercury or cadmium which are both toxic materials. Although dry cell batteries are not a hazardous waste under the Alberta Environmental Protection and Enhancement Act, operators may want to consider returning the batteries to the manufacturers or using other special handling methods. However, due to their toxic contents, all batteries should be handled as special wastes and should not be included in landfilled waste.

MINIMIZATION OPTIONS

Reduction:	Use on line electrical power rather than battery power whenever possible. Use solar operated appliances. Use battery powered appliances efficiently. Follow maintenance directions for rechargeable batteries. Purchase batteries with the highest service life. Purchase batteries with reduced mercury and cadmium contents.
Reuse:	Use rechargeable batteries, preferably those with reduced cadmium content.
Recycling:	Not available.
Energy Recovery:	Not available
Disposal:	Unserviceable batteries should be exported from the site. Some manufacturers and retailers have arrangements for the return of dry cell batteries for disposal, particularly for rechargeable appliances. Otherwise, dry cell batteries may be disposed of at an approved landfill or sent to an approved hazardous waste management facility.

BATTERIES - LEAD ACID

Examples:	RV and solar or wind storage batteries.
Potentially hazardous:	Yes

Discussion: The contents of these batteries are both toxic and corrosive. When not in use, they should be stored in designated locations. Storage facilities should protect the batteries from damage and contain any spills during storage, maintenance or charging. The conditions for storing and shipping batteries prior to recycling or disposal are specified in the Waste Control Regulation of the Alberta Environmental Protection and Enhancement Act.

MINIMIZATION OPTIONS

Reduction: Battery life may be extended by conducting regular battery maintenance such as cleaning posts and maintaining fluid levels.

Use battery warmers prior to starting in cold weather.

Use only distilled water when adjusting battery fluid levels.

Prior to purchase of new batteries check if the battery can be recharged or reconditioned. Often batteries fail to take a charge because they are cold, frozen or require maintenance.

Reuse: Return the battery to a reconditioner.

Recycling: Return batteries to suppliers or directly to scrap dealers for recycling.

When available, collect deposits on returned batteries or claim a credit for used batteries returned.

Energy Recovery: Not available

Disposal: Lead-acid batteries are a hazardous waste and must be disposed of at an approved hazardous waste management facility.

CLEANERS - LODGE, EQUIPMENT AND SHOP CLEANERS

Examples: Floor, sink, shower, bathtub, window, drain and toilet cleaners; laundry soaps, detergents, and additives. Shop cleaners such as solvents are also included.

Potentially hazardous: Yes.

Discussion: This category includes many different products which may be used for cleaning. The uses will range from washing dishes to washing lodge and shop floors. Cleaners may contain toxic, corrosive or flammable chemicals.

Cleaners are often used by mixing with water. In remote settings the mixtures are usually disposed of into sewage systems or may be broadcast into the environment. In these settings sewage systems are often not designed for treating these chemicals before they are released into the environment.

Waste minimization for cleaners relies on reduction through careful application and selection of less hazardous products.

MINIMIZATION OPTIONS

Reduction:

Dispense cleaners from bulk supplies into refillable dispensers. Soaps in guest rooms may be dispensed from refillable wall dispensers.

Clean drains with a metal snake or plunger.

Clean drains regularly with boiling water.

Clean surfaces regulary and as spils occur to reduce the need for strong cleaners.

Use alternative cleaners such as vinegar, baking soda, borax, hydrogen peroxide, lemon juice and salt. A variety of house keeping waste management booklets are available which offer advice on environmentally friendly cleaning products and practices.

Purchase biodegradable cleaners.

Contact a supplier of environmentally responsible cleaning products for appropriate alternatives.

Use cleaners as required rather than according to an arbitrary schedule.

Clean with water unless additives are necessary to achieve results.

Dilute cleaners with water according to the minimum concentration required to do the job.

Prepare meals and use foods that minimize the amount of greases and oils to be handled during clean up.

Request guests supply and take home their own toiletries such as soaps and shampoos.

Maximize the use of off site laundry facilities for staff and guests.

Ask that guests bring enough clothes to mimimize the need for laundering during their stay.

	Dispense mechanical oils and greases carefully using drip catchers and funnels to minimize the need for cleanup. Reduce the need for mechanical oils and greases and associated cleanup by selecting technologies which minimize the need for these materials. Where possible conduct maintenance and repair of equipment off site to avoid the need to use associated cleaners on site. Maximumize the use of dry cleaning techniques as scraping and wiping with washable rags as much as possible. Use the minimum amounts of solvent necessary to be effective. Ensure solvent containers are closed when not in use.
Reuse:	Reuse cleaning solutions until they are no longer effective. Use and reuse dry cleaning materials such as rags as often as possible. Used courtesy soaps may be offered to charitable organizations.
Recycling:	Use a recycling system for solvents in shop areas and recycle solvents through a solvent recycler.
Energy Recovery:	Not applicable.
Disposal:	Be sure cleaning solutions are discharged into approved and well maintained sewage systems. Discuss preferred cleaners with sewage system specialists and local sewage treatment authorities. Caustic liquids, contaminated sludges and other hazardous cleaning wastes should be disposed of through an approved hazardous waste management facility.

CONSTRUCTION AND LANDSCAPING WASTES

Examples:	Dimension lumber, plywood and logs (treated and untreated), concrete and masonry, wall finishings such as dry wall and paints, carpet, insulation materials, excavating and grading materials.
Potentially hazardous:	Yes. Some materials such as paints and associated solvents and thinners may be hazardous.

Discussion:

Lodge construction is likely to be the period of most intense waste generation. The waste produced may be awkward to handle and include hazardous materials. Waste reduction during construction may result in significant reduction in virgin material costs as well as reducing waste handling and export costs. Finding uses for construction waste on site will also reduce the need for indefinite storage of materials deemed to expensive or difficult to export following construction.

MINIMIZATION OPTIONS

Reduction:

Prepare accurate specifications and materials lists during the design stage to allow for reliable estimates of material needs.

By accurately estimating the quantities required for a project, both the construction and waste disposal costs can be minimized.

Use designs which minimize the need to import materials to the site.

Make use of existing topography and minimize land disturbance as much as possible to reduce the need for materials for retaining walls and slope stability.

Maximize the use of existing vegetation by maintaining existing trees and shrubs in the new landscape designs.

Incorporate existing man-made features such as structures and timbers into new designs or include the reuse of materials from dismantled structures.

Require contractors to remove all of their construction wastes from the site and avoid labour only contracts to encourage waste minimization.

Minimize the use of treated wood. This will reduce the amount of potentially hazardous wood or preservative waste and will facilitate other uses for unused supplies.

Design for and order custom sized materials such as wall board to minimized the need for cutting and trimming on site.

Use water soluble paints to avoid the need for solvents during painting.

Reuse:

Use on-site clean rubble and demolition wastes as fill to create landscape features.

Use salvage sources of materials. Wood, brick, ceramics, ironwork, window frames, plumbing fixtures and furniture may all be salvaged or purchased from suppliers of used building materials.

During construction, save top soils and sub-soils in separate piles and reuse them during the construction of new features.

Carefully store excess materials for use on future projects.

Recycling: Provide space on the construction site for used materials to be carefully stored and protected for possible reuse or recycling applications.

Chip woody vegetation which is being removed on-site and use the chips as a mulch or soil amendment in the new construction.

Chip or grind unused wood materials for use as mulch or soil amendments in land reclamation following construction.

Using recycled materials can indirectly reduce wastes by providing a market for products manufactured from recycled materials.

Use top soil produced from your own on site or commercial off site composting operations rather than purchasing naturally occurring top soils or soil ammendments such peat moss.

Use products made from recycled plastic in deck, fence, boardwalks and other construction. For example, plastic lumber is long-lasting and may not require painting. Plastic is a good alternative to treated products in areas, such as wetlands, where there may be concerns about the leaching of chemicals from treated materials.

Use mats made from used tires as an all season trail bed to protect sensitive areas on access routes.

Energy Recovery: Save untreated wood wastes and protect them from contamination so they may be used as a fuel source for wood burning appliances.

Disposal: If not contaminiated by hazardous materials construction wastes may be deposited in approved landfill sites. Hazardous wastes must be disposed of at an approved hazardous waste management facility.

FILTERS

Examples: Oil filters, fuel filters, air filters which may be used on ATV equipment, construction equipment or electrical generators.

Potentially hazardous: Yes. Undrained oil filters are a hazardous waste.

Discussion: Undrained oil filters are a hazardous waste and may not be disposed of in a landfill. Other filters may be hazardous wastes depending on the materials they contain and their quantity. There are several well developed options for reuse and recycling of filters.

MINIMIZATION OPTIONS

Reduction: Maximize the use of technologies which minimize the need for oil filters and associated maintenance on site.

Drain filters overnight into used oil containers.

Change filters only as needed according to an accepted monitoring method such as oil pressure readings, mileage or operating hours.

Reuse: Use washable, reusable filters. Several types of washable filters and cleaning systems may be available for your equipment.

Recycling: Use filter crushing equipment to recover used oil and reduce the volume of filters prior to recycling.

Arrange for collection of filters by filter recyclers or oil recyclers.

Energy Recovery: Not available.

Disposal: Only drained filters may be placed in landfills. Filters must be drained for twenty-four hours before disposal. Undrained filters must be disposed of at an approved hazardous waste management facility.

FUELS - COMPRESSED GASES

Examples: Propane for lighting, heating and cooking appliances, and power plants.

Potentially hazardous: Yes.

Discussion: It is always cost effective to ensure that energy is used wisely and safely. The following options will ensure that compressed gases are not wasted and lodge safety is maintained.

MINIMIZATION OPTIONS

Reduction: Use propane wisely through such practices as energy efficient cooking, minimizing vehicle idling and turning down thermostats when living and sleeping quarters are not in use.

Have equipment inspected and maintained regularly to prevent safety hazards and ensure propane is being burned efficiently.

Store portable tanks in an area protected from the weather and moving equipment.

Reuse: Not applicable.

Recycling: Not applicable.

Energy Recovery: Not applicable.

Disposal: When storage tanks are no longer required, return them to suppliers for disposal or reuse.

FUELS - LIQUID PETROLEUM

Examples: Gasoline, diesel fuel, jet fuel, kerosene.

Potentially hazardous: Yes.

Discussion: Due to the nature of the location, work, and equipment, liquid fuels are likely to be used in lodge operations. Fuels may be transported and stored under a variety of conditions and in a variety containers. Containers can range from a small fuel bottle for portable stoves to larger lodge based storage tanks holding hundreds of litres.

The greatest waste minimization may be achieved through spill prevention during transfers from storage tanks to equipment tanks. This may be achieved through the use of well maintained hoses, nozzles and drip containment equipment. All fuel storage areas should include leak proof berms or other containment facilities capable of holding the capacity of fuels stored.

Reducing fuel consumption will also result in reduced emissions and improved air quality.

MINIMIZATION OPTIONS

Reduction: Maximumize the use of technologies which minimize the need for liquid fuels use and storage on site.

Consider fuel efficiency when purchasing new vehicles and equipment.

Plan vehicle use to reduce the number of trips required.

Maintain equipment in efficient running order and operate it to minimize fuel consumption.

Use smooth driving habits and drive at moderate speeds.

Keep tires properly inflated.

Use lubricants which have low cold temperature viscosity in winter to reduce fuel consumption.

Leave vehicles idling only when absolutely necessary to ensure operation. Develop company policies which specify when engines may be left running.

Choose alternative fuels such as propane, natural gas and methanol which reduce emissions and which may reduce operating costs.

Maintain all pipes, hoses and connecting fittings to prevent fuel leaks.

Handle fuels carefully to prevent spills when transferring between tanks and containers.

Fuels should be stored in a prepared area well away from moving equipment and fires.

Base fuel handling for vehicles and aircraft off site and maintain only minimal amounts of fuels on site as needed for emergency use.

Reuse: Not applicable.

Recycling: Not applicable.

Energy Recovery: Not available.

Disposal: Contaminated fuels must be disposed of at an approved hazardous waste management facility. Uncontaminated fuels should be stored in proper containers, be protected from the elements and used in the appropriate equipment.

FUELS -SOLID

Examples: Wood, Coal.

Potentially hazardous: No. Emissions from poor combustion can be toxic.

Discussion: Wood burning may be an essential part of the lodge experience. However, it should be remembered that wood smoke can contain by-products of combustion which are harmful. Where wood cutting is not feasible or is regulated coal may be a preferred alternative with similar air quality concerns.

MINIMIZATION OPTIONS

Reduction: Use the most efficient burning technology available for intended use and operate for maximum efficiency.

Be sure guests are well informed about the operation of the burning equipment.

Establish guidelines relating to when fuels should be burned.

Store fuels properly to protect burning efficiency and storage life.

Reuse: Not applicable.

Recycling: Wood considered unsuitable for fuel may be chipped for mulch on pathways or other grounds applications.

Energy Recovery: Not applicable.

Disposal: Not applicable.

GLASS

Examples: Empty food jars, beverage containers, broken windows.

Potentially hazardous: No.

Discussion: Most glass in lodge operations will be generated in lodge kitchen activities. Due to the potential for contamination from food, these containers should always be rinsed before returning for reuse or recycling. Many glass containers such as beverage bottles may be reused. Check with the relevant recycler to determine if labels need to be removed or colour separated. Most other container glass can be recycled. The opportunities for recycling window glass are limited.

Depending upon the amount and type of handling required the risk of glass breakage may be high. If this is anticipated to be a problem it may be appropriate to avoid glass containers. However, properly handled, the smashing of empty glass containers being saved for recycling may present a viable option for reducing waste volume prior to transport. Crushing may be less feasible for other container materials such as plastic.

MINIMIZATION OPTIONS

Reduction: Purchase foods in bulk or concentrate and dispense through bulk dispensers rather than individual containers. For example, bulk powdered beverages will generate less waste than premixed liquid drinks in glass or other containers.

Purchase foodstuffs in returnable containers made of glass or other materials.

Reuse: Use glass jars for storage of materials.

Recycling: Return beverage containers to bottle depots.

Return other container glass to community glass collection programs.

Crushed glass may be for used as road base or construction backfill material when mixed with other aggregates. Crushed glass may also be used in geo-textile sleeves for underdrain systems.

Energy Recovery: Not applicable.

Disposal: If reuse and recycling options are not available, glass may be disposed of in an approved landfill.

METAL

Examples: Food tins, beverage cans, shop supply containers, paint containers.

Potentially hazardous: Yes, depending on contents of the container.

Discussion: Metal containers are used for a variety of products ranging from paint to food. Since metals are readily recycled and markets are well established, it may be preferable purchase products in metal containers rather than in plastic or glass.

It is often helpful to separate metals into ferrous (steel/iron) and non-ferrous metals. If non-ferrous metals (copper, aluminum, brass) can be separated, greater value may be obtained for the individual metals.

MINIMIZATION OPTIONS

Reduction: Purchase supplies in bulk containers to reduce the number of smaller containers which must be recycled.

Crush empty containers to reduce the volume of waste that must be stored and transported.

Reuse: Buy food supplies which come in reusable containers and return containers for reuse.

Recycling: Segregate aerosol cans from other containers and return to an aerosol recycling operation.

Purchase a portable can evacuator to remove residues from aerosol cans before placing cans in a metal recycling bin.

Remove labels, wash, and return food cans to a recycling depot or scrap metal dealer.

Return beverage containers to a local bottle depot.

Clean other containers and include with recyclable metals.

Energy Recovery: Not applicable.

Disposal: Although metal containers may be disposed of in approved landfills, the well developed recycling options should preclude disposal. Establish a practical segregation system which is workable for lodge employees and guests.

If residues such as adhesives or paints remain in containers, they may require disposal through an approved hazardous waste management facility.

OILS - CHAIN

Examples: Chain saw oil.

Potentially hazardous: Yes.

Discussion: Due to their external use, these oils are often dissipated into the environment. Careful application and the use of alternative products offers an opportunity to reduce wastes and environmental impacts.

MINIMIZATION OPTIONS

Reduction: Apply oil only as needed and dispense from bulk supplies.

Use biodegradable oils.

Reuse: Filter used oils from other applications (such as crankcase oils) and use as chain oils if appropriate.

Recycling: Not applicable.

Energy Recovery: Not applicable.

Disposal: Contaminated oils must be disposed of through an approved hazardous waste management facility.

OILS - ENGINE

Examples: Crankcase oils.

Potentially hazardous: Yes.

Discussion:

If equipment using oils such as traditional electrical power plants are used on site regularly, or as backup, oils may constitute a significant or problematic volume of potential waste. Fortunately, most petroleum oil products can be recycled. Problems may occur when oils are not stored with care, spill containment is not used, or undrained filters and other containers are handled and stored carelessly.

While most petroleum based fluids are accepted for recycling, operators must discuss with their recycler which fluids may be mixed in waste oil tanks. Synthetic oils and fuels, for example, cannot be recycled with petroleum based oils and should remain segregated. Solvents and coolants must not be mixed with petroleum based oils.

All liquid storage areas should include leakproof berms or other containment facilities capable of holding the capacity of liquids stored.

MINIMIZATION OPTIONS

Reduction:

Maximumize the use of technologies which minimize the need for oils.

Conduct maintenance which requires the handling of vehicle fluids off site.

Mix oil and fuel combinations carefully to manufacturers specifications.

Purchase quality equipment with well sealed components to prevent leaks.

Purchase equipment with automatic shutdown devices to reduce oil losses.

Avoid arbitrary oil changes. Use monitoring methods such as sampling and testing oil, recording hours of operation, kilometres travelled, or fuel consumption to establish the need for oil changes.

Encourage equipment manufacturers to specify recommended maintenance procedures in warranty agreements which reduce reliance on arbitrary oil change schedules.

Prevent accidental spills and leaks by inspecting hoses, fittings and seals on equipment regularly. Install equipment such as oil pan plugs which can be connected to hoses for direct draining into a used oil tank.

Place absorbent pads under equipment when draining and replacing fluids in the field and around drip pans in the shop. Backup maintenance in the shop and in the field with drip pans, absorbents or other containment equipment with enough capacity to contain the amounts of fluids involved.

Use containment around storage, handling and dispensing areas to avoid soil and water contamination.

Consider using longer lasting synthetic oils to reduce the frequency of changes.

Oils should be stored well away from moving equipment and fires.

Reuse: During parts maintenance, save drained oils in clean containers for replacement upon completion of maintenance.

Save used oils for use as saw chain oils or other general lubricating needs.

Recycling: Recycle oils and purchase recycled oil.

Drain and collect the residual oil from filters and other parts for recycling.

Energy Recovery: Some used oil collection companies produce industrial fuels from used oils.

Disposal: If not recycled used oil must be disposed of at an approved hazardous waste management facility.

OILS AND GREASE - COOKING

Examples: Cooking oils, greases or fats from food products.

Potentially hazardous: No.

Discussion: Oils and greases used in cooking are prone to cause problems in remote operations. If not separated from sewage or grey water they can clog drains and sewage facilities and create wildlife related problems at sewage treatment sites. The need to clean up these products can lead to unnecessary use of detergents or soaps which in turn further contaminate waste water.

Waste minimization practices involving food service should be confirmed with health authorities.

MINIMIZATION OPTIONS

Reduction: Maximize the use of menus which minimize the need for greasing.

Use greases within foods such as greasing pans with chicken skin rather that using purchased greases or oils.

Maximize the use of `no-stick' cooking ware.

Reuse: Reuse greases such as bacon fat as much as possible.

Recycling: Drain greases and oils into sealable containers and arrange for delivery to rendering agents.

Energy Recovery: Not applicable.

Disposal: These wastes may be disposed of in an approved landfill. Food waste should not be fed to wildlife.

ORGANICS

Examples: Domestic food waste.

Potentially hazardous: No.

Discussion: Organic food waste is often the largest waste stream produced by kitchen operations. This waste has a low environmental hazard but is often mixed with other wastes produced by lodge operations which limits alternative handling practices. If composting options are to be used, care must be taken to keep organic waste segregated from other lodge and kitchen wastes.

Food waste may take up significant space in landfills and can cause problems associated with the habituation of wildlife.

Waste minimization practices involving food service should be confirmed with health authorities.

MINIMIZATION OPTIONS

Reduction: Purchase perishable food in amounts which can be consumed before spoiling occurs.

Prepare and serve food in proportions which will be consumed during the meal.

Maximize the use of non-perishable or longer shelf life foods.

Offer half or child portions to all guests to reduce unconsumed food.

Reuse: Unused food may be offered to charitable organizations such as food banks.

Discuss with the appropriate approval agencies the possibility of having livestock on site to consume organic waste.

Some unused foods and food wastes may be offered to farms as livestock feed.

Recycling: Investigate the possibility of mid scale composting on site or contributing to a community central composting project. Composting on site may facilitate reclamation projects or trail maintenance by providing a supply of soil amendment material. Composting in lodge situations should be discussed with local wildlife managers due to the potential for wildlife conflicts.

Composting will require careful separation of compostable material from those materials which are not compostable or should be limited in their volume within the composting material.

Maximumize the use of menus which minimize the potential for non-compostable or difficult to compost food wastes.

Chip any wood wastes such as packing crates and pallets on site for use as mulches on trail surfaces or bulking agents in compost.

Energy Recovery: Some energy recovery may be possible in approved waste-to-energy incinerators but organic food wastes generally have a low heat content and approved incinerators are likely to be too costly.

Disposal: Organic wastes may be disposed of in an approved landfill. Food stuffs should not be fed to wildlife.

PAPER PRODUCTS

Examples: Packaging (cardboard, paperboard), office paper, papertowels, newspapers.

Potentially hazardous: No.

Discussion: Waste minimization opportunities for paper products often require the ability to recognize and segregate different grades of paper products. Paper grades likely to be found in lodge operations include:

- Old corrugated containers (OCC): Boxes constructed of a waffled or corrugated layer of cardboard sandwiched between two smooth outer sheets, usually brown in colour. Most commonly used for packaging.
- Paperboard or boxboard: Single layer cardboard packaging such as cereal boxes, facial tissue boxes and small parts boxes.
- Old newspapers (ONP): Old newspapers, and in most cases, any inserts delivered with the newspaper.

- Bond or office papers: Letterhead, photocopy, typing and other office papers. Often sorted into white and coloured grades.
- Mixed paper: Mixes of the above grades, usually excluding old newspapers.

Waste paper, particularly corrugated containers, can be a very high volume waste associated with kitchen supplies. Reduction in the amount of paper and cardboard to be disposed of can reduce waste handling problems, reduce storage space, reduce trips to landfill sites and lead to less operating time for approved incinerators.

Many communities operate recycling programs for corrugated cardboard, newsprint, and bond paper. Recycling programs for paperboard and mixed paper are less common.

Packaging is a major source of corrugated cardboard and paperboard. Reduction of these wastes will require working with suppliers.

MINIMIZATION OPTIONS

Reduction:

Use returnable, collapsible shipping boxes.

Order supplies in bulk packaging.

Make use of products which use recycled packaging materials.

Use cloth towels and napkins instead of paper products.

Use reusable cups instead of disposable paper or styrofoam cups.

Cancel unnecessary newspaper and magazine subscriptions.

Photocopy only when necessary and use two sided copying.

Conduct office operations off site.

Maximize the use of electronic records for office activity conducted on site.

Do not crumple used paper. Place it flat in storage containers to conserve storage space and reduce the volume to be exported from the site.

Reuse:

Use newspapers instead of new paper towels to clean windows.

Use waste paper as packing material.

Return used equipment parts in used packages.

Use both sides of office papers before depositing them for recycling.

Use the back side of office papers for note pads and rough drafts.

Recycling: Segregate used OCC, ONP, bond papers and mixed paper. Protect them from contamination by food waste and other substances. Deliver papers to existing community recycling system.

Energy Recovery: Paper may be used as an energy source in an approved waste-to-energy incinerator.

Disposal: Where paper products cannot be placed in existing recycling systems, they may be disposed of in an approved landfill. Papers, particularly OCC, should be compressed to make efficient use of bins and reduce collection costs.

PLASTIC CONTAINERS

Examples: Plastic oil containers, beverage containers, food containers and wraps, cleaning and toiletry supply containers.

Potentially hazardous: Yes, depending on contents of container.

Discussion: Empty plastic containers may be a significant waste stream generated by lodge operations. Containers may range in capacity from less than 1 litre to 205 litre drums.

Poor storage and handling of empty containers can lead to unnecessary spills. Damage to containers or contamination by water may reduce the recyclability of empty plastic containers. In order to prevent these problems, empty containers should be drained to make use of all contents and stored indoors. Depending on the previous contents and type of sewage system it may preferable not to rinse containers on site prior to storage.

MINIMIZATION OPTIONS

Reduction: Follow the reduction options suggested for the materials held by the containers.

Order in bulk and dispense liquids from larger containers (20 litre pails and 205 litre drums) or bulk tank dispensers.

Order liquids in larger containers (4 and 20 litre) rather than many small containers (1 litre).

Allow containers to drain fully. Where possible, containers should be allowed to drain for 24 hours.

Ask guests to supply their own toilet supplies or to bring containers to be filled from bulk supplies at the lodge.

Reuse: Fill smaller containers (1 and 4 litre oil jugs, hand held cleaning spray bottles, small shampoo bottles) from bulk containers for use.

Return containers for reuse by suppliers.

Purchase liquids from suppliers who accept the return of plastic containers for reuse.

Reuse containers such as 20 litre pails for refilling from bulk suppliers.

Recycling: Plastic containers may be cleaned and segregated according to the type of resin (look for the recycling symbol usually located on the bottom of the container) and returned to plastic recyclers or community recycling programs.

Purchase materials in containers which are manufactured from recycled plastics.

Purchase liquids from suppliers who accept the return of plastic containers for recycling.

Make the return of empty containers part of the purchasing contract.

Energy Recovery: Not applicable.

Disposal: When containers must be disposed of they should be drained for twenty four hours and rinsed if necessary. Many plastic containers may be disposed of at an approved landfill site. Containers which have held hazardous materials may require disposal at an approved hazardous waste management facility.

TABLEWARE

Examples: Materials used to serve food such as tableware, knapkins and food dispensers.

Potentially Hazardous: No

Discussion: A desire for convenience or to save water and energy may lead to the use of disposable items in food service. This practice can lead to significant amounts of waste.

Waste minimization practices involving food service should be confirmed with health authorities.

MINIMIZATION OPTIONS

Reduce:	Use durable material for tableware to reduce losses through breakage.
	Use bulk condiment and cream dispensers.
	Reduce the need for disposal or laundering by using table surfaces or coverings which may be wiped clean rather than washable table cloths.
Reuse:	Use reusable table covers, knapkins, and place mats.
	Encourage clients to bring their own reusable cups or glasses.
	Provide hooks or trays where guests can hang place their cups in a personalized space to avoid washing each time a drink is taken.
	Use reusable coffee filters.
	Package take-out meals in plastic containers rather than disposable wraps, boxes or bags.
	Provide take-out drinks in reusable containers.
Recycle:	Provide take-out drinks in recyclable containers.
	Store and investigate markets for broken tableware rather than placing in the trash.
Energy Recovery:	Not applicable.
Disposal:	Food handling materials may be disposed of in landfills when their service life is complete.

National Library of Canada
Bibliothèque nationale du Canada
3 3286 50693 2249